THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Economy of the Electric Motor	483
The American Association for the Advancement of Science	484
Designing a Bipolar Drum Dynamo.—I. (*illustrated*)	485
Dead Weight of Cars	485
The Siemens & Halske Process of Gold Recovery	486
Feed Water Filtration	486
On the Electrical Resistivity of Bismuth at the Temperature of Liquid Air (*illustrated*)	487
The British Association:—Screw Gauge	488
Tests of 300 H.P. De Laval Turbine	489
The Potential of Steam	490
International Submarine Telegraph Memorial	491
Correspondence:—Measuring Instruments	492
Alternate Current Switch Gear	492
The Hookham Meter	493
Concentric Cables	493
The National Memorial	493
Business Notices, &c.	493
Coal Cutting by Electricity (*illustrated*)	495
Solid Cast Steel Special Work (*illustrated*)	495
Transmission of Power in Mines.—V.	496
The Institution of Junior Engineers	496
Electrical Factories and their Machinery.—IV. (*illustrated*)	500
The Delany System of Machine Telegraphy (*illustrated*)	501
Electric Lighting Notes	503
Electric Traction and Motive Power Notes	504
Telegraph and Telephone Notes	505
Contracts Open and Closed	505
Notes	506
City Notes	509
Traffic Receipts	510
Share List of Electrical Companies	511
Applied Electro-Chemistry.—II. (*concluded*)	512
New Patents	514
Abstracts of Published Specifications	514

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THE ECONOMY OF THE ELECTRIC MOTOR.

ALTHOUGH the economy of the electric motor has been a good deal insisted on during the past two or three years, we doubt very much whether its great merits are sufficiently recognised even among electrical engineers. When the substitution of electrical for other methods of driving results in an immediate economy of 34 tons of coal per week, which has actually occurred at Sir William Gray's shipyard, West Hartlepool, and when an electrical transmission system at some north country ironworks yields a saving of £3,000 per annum, such facts deserve to be writ large, if not in letters of gold. Nor can it be said that such instances are rare The National Arms Factory at Liège, where electric motors are almost solely employed, make a rifle in 10 hours with an expenditure of 1½ H.P. per hour, while in other factories where mechanical transmission is employed, more than double this power is used up in the same period. Mr. Anderson has recently shown in his British Association paper, which was published in our last issue, that electricity for crane work is much more economical than other means. Curiously enough it is the mechanical rather than the electrical engineer who has been the most ardent advocate of the electric motor, and it is before the mechanical engineering societies where the most striking results of electrical driving have been published. Mr. Selby Bigge, Mr. Richardson, Mr. Panton, and Mr. Anderson, who have done yeoman service in establishing the economical working of the electric motor, are first and foremost mechanical engineers. No doubt mechanical men are directly concerned in using the most economical transmission systems, and there is little doubt that they are very much alive to the importance of electric driving.

Col. Henry F. Swan, in his Presidential address to the North East Coast Institution of Engineers and Shipbuilders, sums up the attitude of the mechanical engineer towards the subject by saying:—"There is no question that electricity is destined to play a very important part in connection with shipbuilding in the future, both as regards portable appliances, and also the general driving of the shop machines. It, of course, involves a certain amount of courage, not to speak of a large expenditure of capital, to abolish existing steam engines, boilers, &c., and replace them entirely by electric power; some establishments are, therefore, dealing with the matter tentatively, whilst at Hartlepool one of the chief yards has been laid out for electric driving entirely, thus abolishing several isolated boilers and steam engines, and dispensing with the necessary attendants; and, in addition, obtaining the facility of being able to use only such individual machines as are actually required from time to time, instead of having, as at present, all machines going, whether wanted or not, which, with the loss of power by transmission through long lines of main shafting, countershafting, pulleys,

belts, involves a total loss of the power transmitted varying from 30 per cent. to as much as 70 per cent."

Although the electrical engineer is occasionally enthusiastic on the subject of electric motors, he has for the most part neglected it. There are, of course, numerous instances of electrical engineering firms demonstrating in their own works the capabilities of the electric motor; but one is forced to the conclusion that they are not active enough in setting forth the merits of electrical driving. We have already seen that mechanical engineers are sufficiently progressive to examine and if necessary, to adopt improved means of driving. But if they are left to find out the merits of the electric motor, it might be a little unfortunate occasionally for the electrical trade of this country.

It thus happens that the difficulty of obtaining data led one prominent firm of iron workers to seek information on the Continent. They found what they sought, and were so impressed with electrical driving, that they immediately gave orders for the complete equipment of their extensive iron-works. It constitutes the most prominent instance of electric driving in this country; but the whole of the plant has been designed and laid down by foreign contractors. This shows how important it is for electrical engineers and manufacturers to closely watch the development of electric driving; not only should they watch, they must go and help the development.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The kindred association of the B.A. has been at work in America, and there the president of Section D, which corresponds with our own Section G of mechanical science, reviewed the artistic element in engineering. If, a few years ago, the relation of art and engineering had required explanation, surely the reply would have been parallel with that famous report on the manners and customs of a certain people, to wit, "Manners, none; customs, beastly." We have emerged somewhat from that state, and America is beginning to do so. But there cannot yet be any great appreciation of appearance in a people which resolutely refuses to acknowledge that American locomotives are inferior in appearance to the neat English machine devoid of meretricious ornament or crude sunset views on the tenders, out of which stage and of the ogee moulding the Americans have not fully emerged. But the intention is there. Even an ogee moulded sand box or dome is a recognition that something should be done, just as the three shipwrecked sailors made a collection, when *in extremis*, in order to place themselves in touch with a religious life. The Americans have made their collection, but they have not saved their souls for all that. One of their own countrymen has called them a nation of parvenus, and sets down their garish wealth of ornament as merely a brazen *exposé* of dollars, for what can a $40,000,000 man do to justify himself? Poor Bernard Shaw himself pities the rich man because he cannot possibly live up to his wealth, and a mere unit million man recently told us how sorry he was for a certain South African multi-millionaire who had been trying to live up to his riches by an acres-purchasing of old masters, and only found happiness in a game of whist at guinea points—to him of no more value than farthings. But we have not much room to cavil at American vulgarity. That huge gold-tipped wrought-iron fence in Darley Dale should alone stop us from that, and there are items in which America has outpassed us in artistic mechanics and engineering. American bridges are ugly, yet in Brooklyn suspension bridge a successful blending of art to Nature has been made, and is sufficient to justify America's claim to some artistic taste. It is said there is only one building in New York with a pretence to beauty, and that the architect was an Englishman, and if this be so, the absence of a compeer to Trinity Church is evidence that the trend of art in America is rather in the more artificial productions of metal than in Nature's materials. Then, again, Americans have had an unfortunate training. How can a young country possibly trim up, grass and quickset thousands of miles of railway banks, as we can do it in England. What possibility is there of artistically treating a chess-board city laid out entirely regardless of natural features? The plan is described by the lecturer as weighted down with dollars, just as we in England have miles of money-weighted hideousness not to be easily swept away. We think, Mr. President Marvin was quite as happy in his text as was Sir Douglas Fox on the English side, and as an artistic production his address was superior, for it was decidedly original; it dealt with a too little considered side of engineering, and it evidenced an undoubted desire of American engineers to do all they can to improve matters, and sweep away the reproach of ugliness from the land. Even the lavish expenditure on ornament which vulgarises the American car, the hotel, and even the church, has its bright side, for it shows that the will is there even if the power to secure the beautiful be yet undeveloped.

An Electrolytic Process of Desilverising Lead.

Ever since the days of the South Sea Bubble, and enterprise took remarkable forms, when our histories tell us that huge syndicates were formed for the purpose of importing asses from Spain, extracting gold from sea water, and silver from lead, it has been known that, given a sufficiently economical process, it would be quite worth while to pass every ton of lead ore that is raised from the ground, through some process to free it from the silver which most of these ores contain. The idea of extracting silver from lead was not so chimerical as some people thought, although with the very imperfect means available in those days, probably the particular scheme alluded to was no better than the other bubbles which were blown. To-day, however, we obtain a means which enables us to overcome the difficulties which hitherto have been thought to be insurmountable. At a recent meeting of the Paris Academy of Science, Mons. Tommasi presented a note upon the desilverisation of lead by means of electrolysis. The principle upon which this is based consists in electrolysing a lead solution, which not only possesses an exceedingly low electric resistance, but even does not give rise to peroxide of lead, which is the most objectionable trouble. Under the action of the current, the lead of the anodes becomes dissolved, and is deposited in the form of a crystalline sponge upon the disc, which serves as a cathode, whilst all the silver contained in the lead being insoluble in the bath, is found precipitated at the end of the operation at the bottom. The process employed by Tommasi is briefly as follows:—The argentiferous lead is cast into the form that it is desired to give to the anodes, which are then suspended in the upper part of the electrolysing apparatus. These are then connected up with the dynamo. There are other details, for which the original paper must be consulted in the *Comptes Rendus* of May 18th, 1896. The disc which constitutes the cathode is placed between the two anodes, and of course communicates with the negative pole of the dynamo. Here the lead, dissolved off from the anodes is deposited. The bath consists of a solution of the double acetate of lead and sodium, or of lead and potassium. When the anodes are dissolved they are replaced by new ones, and the silver deposited is melted with nitrate of soda and borax and then cast in the ingots. The same is done with the spongy crystalline deposit of lead. The object of treating the silver deposit with nitrate of soda is to convert the arsenic and antimony, which all lead contains, into sodium salts. The net result of this process, then, is to obtain pure silver, eliminating from it antimony and arsenic in the form of sodium compounds. Tommasi's note on this process was presented by Mons. Moissan, and seemed to attract a good deal of attention, as it possesses some novel features.

DESIGNING A BIPOLAR DRUM DYNAMO.

By RANKIN KENNEDY.

I.

The question is often put; What are the simplest arithmetical processes employed in designing dynamos? Before proceeding to explain and illustrate the processes generally used, we lay down certain postulates and statements.

Known Quantities.

The output is known; it may be given in watts only or in voltage and current, or in horse-power, thus a machine may be required to give 4,500 watts or 45 amperes at 100 volts, or 6 horse-power. Hence we also know the voltage and current, number of revolutions per minute is known, for it is generally given in specifications, but if not it is found by rules to be given further on.

Rules for Armature.

1. The length of the armature is not to be less than 1 diameter nor more than 3 diameters.

2. The length of the armature in machines over 6 inches diameter is not to be less than 1½ diameters nor more than 3 diameters.

3. The peripheral speed of armatures to be the same for all sizes, 2,400 feet per minute.

4. In the whole range of dynamos we take the diameters 4, 6, 8, 10, 12, 16, 20, 24.

5. The diameter suitable for a given output is found by calculating out the outputs for the diameters in 4th rule with the lengths according to 2nd rule, and tabulating the results, thus we will have a table of dynamos as under, and the outputs will be as watts $= n, a, d^2, 015$, where n is number of revolutions, a length of armature, d diameter, revolutions, or n, is found by dividing 2,400 by three times the diameter in feet. 2,400 is the peripheral speed.

Size of machine. d a	Output watts. n, a, d^2 0·015.	Revolutions. $\frac{2,400}{3 \times d}$	Remarks.
4 × 4	2,250	2,400	In output column only the first two figures of the number found for watts output is entered, and the smallest and largest size of each diameter is given. Intermediate sizes are found by simple proportion of a, or length and output.
4 × 8	4,500	„	
6 × 8	7,000	1,600	
6 × 14	12,000	„	
8 × 12	13,000	1,200	
8 × 20	23,000	„	
10 × 15	20,000	900	
10 × 25	33,000	„	
12 × 18	40,000	800	
12 × 30	65,000	„	

Armed with this table we can at once find the fundamental dimensions of every dynamo and motor in the series, namely, the diameter and length required for any output of armature.

Suppose we want a machine to give 15,000 watts, we look down the table and find it comes between 13 and 20 units, therefore the diameter is 8 inches.

For length we make it a simple proportion, if 20 inches gives 20 units what will give 15?

$$\frac{15 \times 20}{20} = 15 = \text{length 15 inches.}$$

By this simple process the armature dimensions of any machine between 2·5 units and 65 units can at once be found by the table.

If slower speeds are required, then the output will be reduced in simple proportion to the speed peripheral in feet. If we made peripheral speed 1,200 the outputs would all be halved and the revolutions halved. It is better to calculate a table for each, beginning with the first size, 4 × 4, we get according to $n, a, d^2, 015$,

$$n = \frac{1,200}{1} = 1,200 \text{ (for } 3 \times 4 = 12 \text{ inches} = 1 \text{ foot)},$$

$$a = 4$$

$$d^2 = 4 \times 4 = 16,$$

then

$$1,200 \times 4 \times 16 \times \cdot 015 = 1152 \text{ watts output,}$$

and so on, we could calculate the whole table again for half the speed.

6. To find the flux or flow of magnetism across the armature (the next step in the design), half the circumference minus one length of the polar gap multiplied by the length of the armature, multiplied by 5, will give us the total magnetic flux.

In fig. 1, G is the polar gap; if we draw a line, x y, through centre of armature and touching opposite poles we see that the pole face is equal to half the diameter minus a polar gap. Now, in the smallest machine, 4×4, the gap would not be more than 1½ inches, circumference halved $= 6\frac{1}{4} - 1\frac{1}{2} = 4\frac{3}{4}$. $4\frac{3}{4} \times 4 = 19$ inches = area of pole face, this multiplied by the induction or flux density per square inch across this area $= 5 \times 19 = 95$ total magnetic flux.

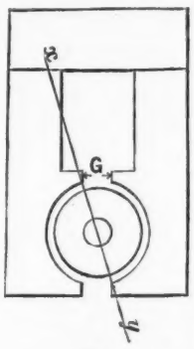


Fig. 1.

In this way the flux for all sizes may be computed, taking the two gaps at ¼th of the circumference or ⅛th each.

7. To find the number of turns of wire in the winding on the armature, divide the voltage by the number of revolutions per minute multiplied by the flux and by ·000001.

Thus if the volts are to be 100 in the 4×4 machine, we have

$$\frac{100}{2,400 \times 95 \times \cdot 000001} = 440,$$

nearly. To compensate for losses 10 per cent. is generally added to this figure for turns of wire on armatures.

8. We have now only to find the section of the wire and its arrangement on the armature, if volts are 100 and output already found 2,250 watts, then $\frac{2,250}{100} = 22 \cdot 5$ amperes, this halved is the current each wire carries on the armature, 11·25 amperes; this can be found by taking the circumference of the armature and finding the smallest wire to carry 11 amperes at a little over 4,000 amperes per square inch; a 17 S.W.G. wire will do this, and wound three deep will give the number of turns.

If we take a 20 part commutator, 12 turns per section will give us 480 conductors, counting all round our armature.

In all larger diameters of armatures 3,000 amperes per square inch of section of wire is taken.

In small sizes, such as we have dealt with, we must sacrifice some efficiency to keep down first cost of machine.

DEAD WEIGHT OF CARS.

The *Street Railway Review* discusses the question of the profitableness or practicability of reducing car weights so as to reduce the proportion of dead to paying load. Part of the interest of its article centres in the insight which it gives of American habits. Ordinarily a 16-foot double motor car weighs 11,100 lbs., and carries only 22 people. In England such a car would carry twice the number of passengers, but the American has an insuperable objection to riding on the top. He prefers to cuddle a stove inside; but, at a push, he does not object to ride outside under certain conditions.

Squeeze him on the end platform with 10 other people, and he endures it. He would submit to be hung on hooks round the car, like carcases in a butcher's row, but he will not be put comfortably on the top. To ride on top is English, and to show even a trace of so vile a taint would expose him to the remarks of a virulent Press. He would, perhaps, be termed a gold bug, or it would be hinted that he was a low tariff man.

Our contemporary admits that several times a day a 22-seat car will be found carrying 60 passengers. Thus the nominal dead weight of 504 lbs. per passenger is really only 185 lbs. It will cost more to build a light car than a heavy one. We may assume that the present cars are a compromise, and that they roughly represent the cheapest construction possible; that the quality of material is equated with the minimum weight. To try if this is so, our contemporary assumes the possibility of halving the weight of a car and calculating the amount that it is possible to spend profitably in doing so. The power to run the lighter car is assumed to be 40 per cent. less than that necessary for the heavy car.

The yearly cost of running a 16 feet car on a basis of $ 015 per mile for power is $540 for a mileage of 36,000. Of this amount, $216 is now to be saved, and this would pay 6 per cent. interest on $3,600. It would, therefore, pay to spend $3,600 per car in order to reduce its weight one-half. As the cost per car mile may be half or double the above, it would appear that from $1,800 to $7,200 could be payably spent, according to the cost of the power on various roads. Obviously, such a reduction of weight would save expenses all along the line, including even ground rent; but as stated, it will be found to entail a great expense to do this. The bicycle, which is put forward as an example of small dead weight, costs about $2 5 per pound of its weight. Light machines may cost $5 00. At bicycle prices and weight ratios a car that must carry 60 persons of, say, 150 lbs. average weight, would weigh 1,800 lbs., and cost $4,500. But in the case of the bicycle, the propelling agent weighs five times as much as the mere car. In the car the passengers do no work; there must be a motor, and it is impossible to make a comparison. On bicycle figures the motor and passengers must not weigh above 9,000 lbs. for a car body and wheels of 1,800. If the motor had to weigh 4,500 lbs. the passengers would at once be halved in number, and at once we have got to reduce the weight of car, apart from the motor, to 900 lbs. If, however, we take the sum of passenger and motor weight, the car must weigh 2,700 lbs., and cost $6,550 for simply the car without the motors. But a structure to carry more than one person begins to increase in weight at a rate greater than the increase of dead load. It is like the bridge which in small spans wants to be very carefully calculated for the load of the train that is to run over it. But in a Forth Bridge of 1,710 feet span, the train is a mere nothing. Let the bridge be reasonably equal to its own weight, and it will carry the train with as little concern as it would a cart. The bicycle is hardly worthy of being considered in the question, except as an instance of very expensive construction for most favourably disposed loading, the expense being due to the use of good materials rendered necessary by small ratio of dead to live load. A railway bridge may cost 4 cents per pound, a bicycle may cost without any special ornament or finish 500 cents. A locomotive may cost 8 cents.

THE SIEMENS & HALSKE PROCESS OF GOLD RECOVERY.

It is most gratifying for us to reproduce from the *Engineering and Mining Journal* of New York, the following letter from Mr. Charles Butters, the well-known chemist, who is no doubt the best authority in South Africa in all practical questions relating to cyanide and gold:

Sir: Some time ago I noticed a short article in the *Engineering and Mining Journal* stating that the Siemens & Halske cyanide process had been thrown out at the Metropolitan mine in Johannesburg, and also thrown out at the George Gooch mine, the reason given being that the process was not a success. I have not replied to this before, because as a political prisoner in the Transvaal, and with other occupations, I have not had the leisure yet to bring this most interesting process, and the results that we had obtained, before your notice. We have been treating for the past two years 3,000 tons a month at the Worcester mine. We have treated at this property about 70,000 tons of material, and the works are a complete success. This success was followed up by the introduction of the process into several other properties. We have been treating about 25,000 tons a month for several months past with most satisfactory results. There will be under treatment on the Witwatersrand by this process, about the beginning of next year, 100,000 tons a month of tailings and slimes. We have been treating at the Robinson mine 6,000 tons of slimes per month, handling 800 tons of cyanide liquor per day, containing in the liquor to be precipitated from 4 dwts. a ton down to 15 and 18 grains, and this liquor is precipitated from 4 dwts. down to 8 or 9 grs., and from 18 grs. down to 3 or 4 grs. It is immaterial whether the solution contains any cyanide or not; it makes no difference whether it is acid or alkaline, and the constitution of the liquid is independent of everything except organic matter. I hope to be able to give you absolute data in reference to the process; but in the meantime I may say that I consider the Siemens & Halske process, as now introduced and perfected by the Rand Central Ore Reduction Company, the most perfect cyanide process in the world. It is a process that has come to stay along with other electro metallurgical processes. I feel that it is my duty to make this statement now, because even so well informed a man as Prof. Christy, of the University, California, has, I hear, made the remark that he understood that the cyanide process that we have introduced was not a success. I always feel that it makes little difference about a metallurgical process whether it is written and talked about or not. If it is good it stands on its own bottom, and if it is no good, all the expert opinion in the world will not make anything of it. I hope to introduce this process into the United States in the coming year.

Charles Butters.

London, England, *September 5th*, 1896.

We have studied so thoroughly for several years this problem of the electrolysis of gold cyanide solutions, and we are so deeply convinced of its great superiority over the zinc process, that when the rumour circulated in the Press that the electrolytic deposition and recovery of gold was a failure at the Gooch and May mines, where it had to be abandoned, we did not hesitate to protest, and to declare that such a failure was an impossibility. (See Electrical Review, March 13th, 1896.)

We do not approve of the use of iron as an anode. There are better anodes which can stand the action of electrolysis without disintegrating, and without decomposing or contaminating the cyanide solution; nor do we consider lead to be a very good substratum for gold, and in our opinion the recovery of gold which coats the lead cathodes by fusing them and then cupelling the alloy, is imperfect and expensive. Still, in spite of these drawbacks, the Siemens & Halske process is much cheaper and better than the zinc process.

Is it not remarkable that this method of recovery of gold by means of zinc shavings, for which more than £31,000 has already been spent in the Transvaal for legal expenses is, so to say, repudiated and abandoned by Mr. MacArthur, who has recently applied for a patent, No. 16,634, 1895, for obtaining gold from solutions, by means of electrolysis, "which will yield satisfactory results with economy in cost, time and labour."

We shall go probably into the details of this process at a later date. Whatever may be its value from a practical and technical point of view, the important fact is, that the deposition of gold by means of zinc shavings is condemned by its reputed father, who now clearly declares that it is superseded by the electrolytic decomposition of gold cynaide solutions.

FEED WATER FILTRATION.

An article deserving of attention appears from Mr. W. H. Odell in *Cassier's Magazine*. It deals with the filtration of feed water for prevention of scale.

It is well known that by heating the feed water before it passes to a boiler, it will usually be purified of lime and certain other salts, but to use steam as is done so often for this purpose usually means the sacrifice of all economy due to feed heating. Mr. Odell describes a plan whereby the water is pumped to the boiler in the usual way, and a circulatory system is introduced containing a sand filter, and a constant flow of water is kept up through the filter from the boiler. The filter abstracts the separated mud and returns clear water to the boiler. Trials and practice have shown that the method is quite effectual.

Further, it is known that pure water alone will remove old scale from a boiler. The reason that old scale does not

become loose is simply because it is as constantly re-cemented in place by the freshly deposited mud. With the filter the removal of the mud as formed removes the re-cementing action and some of the old scale dissolves, and finally the scale flakes off. This process of filtration deserves attention. There is nothing new in the idea. The principle of constant circulation is now old. It is embodied in the Hotchkiss and similar boiler cleaners, and has received far less attention than it deserves; but it appears certain that a system of circulation with a filter, or a place of quiet deposit, is quite sufficient to deal with all the water and sediment introduced to the boiler. We may assume the boiler full of a thick water. We then start the circulator, and the removal of the mud commences, and the solution becomes thinner every minute. So long as the circulator deals with more weight of mud than the feed introduces, the decrease of suspended matter will continue, and the water becomes bright and remains so. The matter suspended in the feed floats on the surface under the action of the ebulition. It easily enters the scummers of the circulatory system, and gets removed. The filtration system demands a daily or periodical wash out. This should easily be arranged for by a counter current. The circulatory deposit system simply requires a blow out on the deposit chamber, and where many gallons are blown out of a boiler on the common system, a few pints only need be lost with the cleaner. There is thus a direct economy of heat. The pumping of feed water directly to a boiler has been described as a barbarism, and it is this when no provision is made for removal of mud. With an economical mud filter or deposit chamber, there is no objection of a serious nature to such a practice, because the use of waste heat for feed heating can be arranged for, and the system demands a minimum of space, which cannot be said of many of the water softening plants arranged for purifying cold water before use. The boiler may legitimately be made part of the purifying chain if the process is one that is truly effective, and does not, as in the crude ordinary way of working, convert the boiler into the mud tank system, the failure of which can be told by one glance at the gauge glasses.

ON THE ELECTRICAL RESISTIVITY OF BISMUTH AT THE TEMPERATURE OF LIQUID AIR.

By JAMES DEWAR, LL.D., F.R.S., Fullerian Professor of Chemistry in the Royal Institution, and J. A. FLEMING, M.A., D.Sc., F.R.S., Professor of Electrical Engineering in University College, London. Received May 19th.*

In the course of last year we published some observations (see *Phil. Mag.*, September, 1895, p. 303)† on the electrical resistance of bismuth at the temperatures of liquid and solid air, in which the resistivity of certain samples of bismuth was measured at various temperatures down to the temperature at which air solidifies. These observations showed some anomalous results. In the case of two samples of bismuth used by us, and prepared by different chemical means, it was found that the resistivity reached a minimum value at a temperature of about $-80°$, and that after that point further cooling increased the electrical resistivity of these samples of the metal. In the case of another sample of commercial bismuth, the resistivity curve was a curve of double curvature. These results, together with the high absolute value of the resistivity of the samples, caused us to feel a strong conviction that different results would be obtained with bismuth prepared by an electrolytic method. Some observers, particularly M. van Aubel, who have investigated the electrical properties of bismuth, have expressed the opinion that bismuth cannot be prepared in a state of perfect purity by any chemical means. Finding the chemical methods of doubtful utility, we accordingly solicited the assistance of Messrs. Hartmann & Braun, who have devoted a large amount of attention to the preparation of pure electrolytic bismuth for the purposes of constructing spirals of bismuth for measuring the strength of magnetic fields. They kindly prepared for us, at our request, a considerable quantity of bismuth by an electrolytic method, which examination showed to be exceedingly pure, and this metal was pressed into a uniform wire with a diameter of about half a millimetre. This electrolytic bismuth is very soft, and in the form of wire can be bent without difficulty. Resistance coils were accordingly constructed of this wire, of a form suitable for use when measured in liquid air and at low temperatures. In the case of one resistance coil, which may be denoted as electrolytic bismuth No. 1, the length of the wire employed was 80·85 cm.; the diameter of this wire was carefully measured with a microscopic micrometer in 20 to 30 places, these diameters having very nearly equal values, and a mean value of 0·05245 cm. The bismuth wire so prepared was mounted on a suitable holder, and its resistance was taken at several different temperatures and in liquid air, the temperatures being in all cases measured by our standard platinum thermometer P_1.*

The results of these measurements were as follows:—

Resistivity of Electrolytic Bismuth. No. I.

Temperature in platinum degrees.	Observed resistance in ohms.	Resistivity in C.G.S. units per cubic centimetre.	Remarks.
+60°·5	4·9857	133,250	At ordinary temperature.
+19°	4·3464	116,180	" "
−61°·2	3·1275	83,590	In ether cooled with solid carbonic acid.
−202°·2	1·5236	40,780	In liquid air.

The curve of resistivity plotted from these data is shown in fig. 1, and in the table the value of the resistivity of bismuth in C.G.S. units per cubic centimetre is given above. These values of the resistivity show that in the case of this pure electrolytic bismuth there is no tendency of the resistivity curve to a minimum value. Down to the lowest temperatures reached in these experiments, the resistivity of bismuth continues to decrease in a perfectly regular manner, and in such a way as to show that it would be no exception, in all probability, to the ordinary law, that resistivity of pure metals vanishes at the absolute zero of temperature. On comparing the results of these measurements with those in the former experiments made with chemically prepared bismuth, it is seen that the electrolytic bismuth used by us has a very much lower resistivity at 0° C., viz., 108,000 units, and it has a lower value than that given by Matthiessen for pure bismuth, which is 129,700. We have, then, an additional indication that the bismuth used by us in the experi-

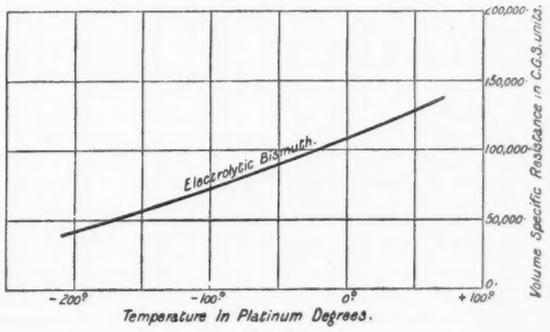


Fig. 1.

* Royal Society, read June 4th, 1896.

† "The Variation in the Electrical Resistance of Bismuth when Cooled to the Temperature of Solid Air," Dewar and Fleming, *Phil. Mag.*, September, 1895, p. 303.

* For details of this thermometer, see Dewar and Fleming on the "Thermo-electric Powers of Metals and Alloys at the Boiling Point of Liquid Air," *Phil. Mag.*, July, 1895, p. 100.

ments in 1895 must have contained sufficient, though slight, impurity to markedly alter its resistivity, and to change entirely the character of the resistivity curve. With this electrolytic bismuth we have repeated the experiments which we made last year, on the variation of the electrical resistance of bismuth when placed transversely to the direction of the force in a magnetic field, and when cooled to the temperature of liquid air. For this purpose we constructed a flat spiral of the electrolytic bismuth, so arranged that its resistances could be measured at ordinary temperatures, and at the temperature of liquid air, by immersing it in a flat vacuum-jacketed test-tube, both when in a powerful magnetic field, and when merely in the terrestrial field. With this electrolytic bismuth we have confirmed the observation which we made last year, with a small sample of electrolytic bismuth, viz., that the effect of a given transverse magnetic field in increasing the resistivity of bismuth is immensely increased by cooling the bismuth to the temperature of liquid air. The figures in the following table will show the actual results obtained in these last experiments:—

VARIATION OF ELECTRICAL RESISTANCE OF ELECTROLYTIC BISMUTH IN MAGNETIC FIELDS OF DIFFERENT STRENGTHS.

Temperature in platinum degrees.	Magnetic field strengths in C.G.S. units.			Remarks.
	Zero.	1,400 units.	2,750 units.	
	Resistance of bismuth coil.			
	Ohms.	Ohms.	Ohms.	
+ 20°	1·679	1·700	1·792	At ordinary temperature.
− 202°	0·5723	1·4435	2·6801	In liquid air.

It will thus be seen that whereas the immersion of the electrolytic bismuth wire, at ordinary temperature, transversely in a magnetic field of strength 2,750 C.G.S. units, only increased its resistance by about 6 per cent., the immersion of the same wire in the same magnetic field increased its resistance to more than four and a half times when it was cooled to the temperature of liquid air, and the effect of the cooling with liquid air is more than nullified by the field, so that the bismuth cooled in liquid air, and at the same time placed in the field, has resistance of 50 per cent. greater than it was when not cooled and not in the field. We are engaged in extending these observations to stronger fields.

The behaviour of electrolytic bismuth in fields of various strengths, and at various temperatures, from 0° C. to 100° C., has been studied by Mr. J. B. Henderson (see *Phil. Mag.*, Vol. xxxviii., 1894, p. 488), and he has given a series of curves showing the variation of resistance of bismuth between these temperatures for fields of strength varying from zero to 22,700 C.G.S. units. Our observations at low temperatures are quite consistent with Mr. Henderson's curves. His curves indicate that at lower temperatures the effect of any given field in increasing the temperatures of the bismuth becomes more marked.

Pressed to its limit, it would appear that pure bismuth, which would in all probability be made a perfect conductor by reducing to the absolute zero of temperature, would be then converted into a non-conductor, if at the same time immersed in a magnetic field of sufficient strength. Both M. van Aubel and Mr. Henderson have pointed out that the temperature coefficient of bismuth at any given temperature is quite altered by placing it in a magnetic field, and it will therefore be a matter of great interest to examine the effect of an exceedingly strong magnetic field as bismuth when cooled to the temperature of solid air.

By enclosing a bismuth wire and a platinum thermometer wire in the same mass of paraffin wax, we have been able to measure the variation of resistance of the bismuth from the temperature of liquid air up to ordinary temperatures at a number of intermediate points, and to determine the resistance both in a zero magnetic field, and in one of known strength; but the results we wish to reserve until we have had the opportunity of repeating them with stronger magnetic fields.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, LIVERPOOL, 1896.

SCREW GAUGE.

Report of the Committee, consisting of Mr. W. H. PREECE (*Chairman*), Mr. CONRAD W. COOKE (*Secretary*), Lord KELVIN, Sir F. J. BRAMWELL, Sir H. TRUEMAN WOOD, Major-Gen. WEBBER, Mr. R. E. CROMPTON, Mr. A. STROH, Mr. A. LE NEVE FOSTER, Mr. C. J. HEWITT, Mr. G. K. B. ELPHINSTONE, Mr. T. BUCKNEY, Col. WATKIN, Mr. E RIGG, *and* Mr. W. A. PRICE, *appointed to consider means by which Practical Effect can be given to the Introduction of the Screw Gauge proposed by the Association in* 1884. (*Drawn up by the Chairman*)

I. THE PAST.

A UNIFORM system of screw threads was first proposed by the late Sir Joseph Whitworth in 1842, and his thread, a compromise of the numerous threads then in use, has become of almost universal use for all large screws—that is, screws of over ¼ in. diameter—in the United Kingdom.

Mr. William Sellers in 1864 introduced another thread in the United States of America, which has come into very general use in that country, and this thread has recently been accepted by the French.

In 1881 the British Association formed a Committee to determine a gauge for the manufacture of the various small screws used in electrical apparatus, clockwork, and for other analogous purposes; and after three years of unremitting labour this Committee, in 1884, recommended a screw gauge which has come into very general use in this country. It was based on the metrical system, and with one slight modification on the system adopted in 1880 by the Swiss watchmakers.

The series of screws recommended is given in the following table:—

BRITISH ASSOCIATION SCREW GAUGE.

Number.	Dimensions in millimetres.		Dimensions in thousandths of an inch.		Threads per inch.
	Diameter.	Pitch.	Diameter.	Pitch.	
I.	II.	III.	IV.	V.	VI.
0	6·0	1·00	236	39·4	25·4
1	5·3	0·90	208	35·4	28·2
2	4·7	0·81	184?	31·9	31·4
3	4·1	0·73	162?	28·7	34·8
4	3·64	0·66	142	26·0	38·5
5	3·2	0·59	126	23·2	43·0
6	2·8	0·53	110	20·9	47·9
7	2·5	0·48	98	18·9	52·9
8	2·2	0·43	87	16·9	59·1
9	1·9	0·39	75	15·4	65·1
10	1·7	0·35	67	13·8	72·6
11	1·5	0·31	59	12·2	81·9
12	1·3	0·28	51	11·0	90·7
13	1·2	0·25	47	9·8	101·0
14	1·0	0·23	39	9·1	110·0
15	0·90	0·21	35	8·3	121·0
16	0·79	0·19	31	7·5	134·0
17	0·70	0·17	28?	6·7	149·0
18	0·62	0·15	24	5·9	169·0
19	0·54	0·14	21	5·5	181·0
20	?0·47	0·12	19	4·7	212·0
21	0·42	0·11	17	4·3	231·0
22	0·37	0·098	15	3·9	259·0
23	0·33	0·089	13	3·5	285·0
24	0·29	0·080	11	?3·152	317·0
25	0·25	0·072	10	2·8	353·0

The form of thread adopted was triangular, the sides forming an angle of 47½°, with the top and bottom rounded off to $\frac{2}{11}$ths of the pitch.

The diameter (D) is related to the pitch (P) by the formula $D = 6\,P^{\frac{n}{n}}$, all measurements being in millimetres, and P having successively the values:—

1 (or $0\,9^0$) millimetre; $0\,9^1$ millimetre: $0\,9^2$ millimetre; $0\,9^3$ millimetre; . . . $0\,9^n$ millimetre. The index (n) thus becomes a convenient number designating the screw.

The reasons supporting these recommendations were fully given in the report submitted by the Committee at the Montreal meeting of 1884. Experience has justified the adoption of this gauge, which is almost universally used by the electrical trade, and is very considerably employed by the clock and instrument makers in the United Kingdom.

It is not proposed to modify it, but there has been great difficulty in obtaining accurate gauges. No official system has yet been adopted by which manufacturers can compare their gauges with the standards, nor has a home been selected to deposit authorised standards for easy reference. British Association screws bought to-day from any screw manufacturer are not necessarily of the same dimensions as those supplied by the same maker a month ago. Screws supplied by different makers vary considerably from each other. Measuring gauges now existing, both male and female, differ largely from one another, and do not give correctly the true form of thread specified

in the original Report. The essential element of the value of screws made to a standard gauge—their interchangeability—has thus never been fully realised.

The British Association, having had their attention called to these anomalies at their last meeting (Ipswich, 1895), appointed a committee to consider the subject, which has now the pleasure to submit its first report.

II. The Present.

The Committee was formed "to consider means by which better practical effect can be given to the introduction of the Screw Gauge proposed by the Association in 1884." It has held many meetings. It has added Colonel Watkin, C.B., R.A., Mr. E. Rigg, and Mr. W. A. Price to its number. It has received great assistance from the Pratt and Whitney Co. of Hartford (Connecticut, United States of America), who supplied each member of the Committee with a copy of their book on "Standards of length and their practical application." It was unfortunately deprived of the services of Mr. Hewitt, who was seized with a very severe illness after the first meeting, but it received from him his paper "On the manufacture of standard screws for machine-made watches," read before the Institution of Mechanical Engineers in October, 1894; a paper which has been of great service. Mr. Griffith, representing the Council, attended regularly, and took advantage of his presence in the United States of America to visit the Pratt and Whitney works.

Evidence was taken by the Committee from large users of the screws. Mr. Willmot, of the Post Office factory, stated that the Post Office had used some tens of millions of screws made to the British Association gauge, and he had never received a single complaint.

Various apparatus for measuring screws and different methods of testing their accuracy were carefully considered and discussed.

The Committee came to the conclusion that it was necessary to consider the subject from the three points of view of the Standards Office, the works manager, and the workman.

1. *The Standards Office.*

This must include not only the custody of recognised and authenticated standards, but also a scientific mode of measuring the dimensions of commercial gauges and screws themselves, and of comparing their accuracy with the authorised standards. The peculiarity of the British Association gauge is this: that material standards are not imperatively necessary. The table of dimensions given at page 2, together with the formula, enables any draughtsman to reproduce the form and pitch to any desired scale on paper. Colonel Watkin has shown to the Committee how to throw side by side for purposes of very accurate comparison a photographic image of—

(*a*) The screw to be examined.

(*b*) The standard with which it is to be compared.

(*c*) A scale which may be divided to $\frac{1}{10000}$th of an inch, the images of these three objects being so close to one another that a comparison to a very high degree of accuracy can be made. The Appendix to this report contains a description of Colonel Watkin's method.

Mr. Price submitted to the Committee a microscopical method of measuring screws. This is described in the Appendix. The screw to be measured is attached to the stage of the microscope, the traversing slide of which is provided with a vernier and scale, while a vertical cross-hair in the eye-piece forms the index of the instrument. When the microscope has been adjusted for clear focus the screw is traversed across the field until the cross-hair intersects the thread of the screw at the desired point. The traversing screw of the slide is then turned until the corresponding point of the next thread is intersected by the cross-hair, and the reading of the vernier on the scale gives the measurement of the pitch with great accuracy.

Mr. Buckney showed also how the angle of the thread could be accurately verified by this method by having suitable hairs.

2. *The Works Manager.*

The Committee, after considering various methods, came to the conclusion that male gauges for ordinary workshop use were best tested as regards pitch and form of thread by a template or "comb" for each number, the accuracy of which has been verified by the photographic method. The screw to be tested is placed against the teeth of the comb, and the correctness of its fit verified by the eye against a light background.

The external dimensions of the screw can be obtained by any good micrometer gauge, and the internal diameter or core by a gauge such as that which is described in the Appendix by Mr. Stroh.

The Committee have failed to discover any very reliable method of testing to any degree of accuracy a female standard gauge. No clearance was allowed in the original definition of the system between the male and female standards. Hence a mathematically accurate male gauge cannot be screwed into a mathematically accurate female gauge. But by allowing a certain margin—a maximum and minimum diameter—an internal compatibility of dimensions is allowed in the workshop gauges, which is of a sound, practical character. The female screw must always be a little larger than the standard male gauge, but this must never exceed what is known as a "good fit."

A working margin is given in Appendix III., by a table, prepared by Mr. Le Neve Foster.

Mr. Price, on behalf of the Committee, has made a series of measurements of certain sizes of B.A. screws which show the limits within which they are obtained in practice. The table (Appendix IV.) indicates that the variation from the full diameter, which must be allowed for necessary inequalities in manufacture, is not a function of the diameter, but is rather in the nature of a constant quantity. This quantity appears to be approximately 1 mil. below the full diameter for all brass screws of sizes Nos. 0 to 11, and 3·1 mils. for all iron and steel screws of the same sizes.

3. *The Workman.*

The measuring gauge, available to the workman as well as to the foreman, is one that need not possess the mathematical accuracy of the standard gauges, but nevertheless it must not be allowed to deteriorate or to maintain false belief in its accuracy. Those that are subject to pressure and friction must necessarily wear, become distorted, and, in time, inaccurate. Hence the Committee were anxious to obtain a mode of comparison which would be free from this source of error. The most important measurement, whose accuracy should be easily verified by the workman, is that of the pitch, and this is easily effected with the "half-nut gauge" described in Appendix IV.

The Committee are pleased to find that the result of their enquiry and discussion enables them to recommend for general use means of comparison which do not involve the wear and deterioration of the gauges. Deformation is confined to the taps and screw plates, and as frequent verification of the manufactured screw is desirable continued accuracy is ensured. With the introduction of simple methods of comparison and measurement errors in the screws issued, and want of interchangeability are rendered improbable in a well regulated shop, and unnecessary in any place.

There remains now to determine a place where material standard gauges are available for immediate comparison, and where the photographic and microscopic methods can be readily applied to verify gauges and to obtain a record of those submitted for examination. This means work to be done, expenses to be incurred, and fees to be paid, as is now done at the Kew Observatory for chronometers, thermometers, &c.

III.—The Future.

The opinions formed by the Committee, after full and exhaustive discussions, for furthering the objects to be attained, may be summarised as follows:—

(*a*) This Committee recommend the construction and housing of the comb form of gauges or templates of the B.A. screw thread, by comparison with which master gauges or templates may be exactly and conveniently verified.

(*b*) That, as no exact system of testing female threads has yet been devised, the Committee restrict themselves to recommending means for keeping male threads to gauge, and this they consider will be sufficient for the purpose of securing practical uniformity in female screws.

(*c*) Male threads can best be measured by the comb, combined with suitably arranged tests to give the correct diameters.

(*d*) That for purposes of verification or standardisation the gauges to be deposited for reference should consist of a complete set of these comb-pieces, and a complete corresponding set of male screws, so that new combs can be compared with those deposited, or male screws can be compared with the standard combs with great accuracy by the photographic or the microscopic method, and that these two methods may be conveniently used to check and corroborate each other.

(*e*) That in order to obtain interchangeability of these male screws for practical workshop use it is sufficient that they should satisfy the following tests:—

(1) There should be no appreciable difference in the fit of the screw with a standard comb having not less than 12 teeth.

(2) The diameter of the core must not exceed that laid down by the B.A. specification.

(3) The diameter of the screw measured over the thread must not exceed that laid down by the B.A. specification.

(4) The diameter of the screw measured over the thread must not fall short of that laid down by the B.A. specification by more than a certain amount, which amount depends on the class of work and purpose to which the screw is to be applied.

The amount referred to in (4) must be settled by the persons in control of the work for which the screws are to be used.

(*f*) They recommend for general use in the workshop the half-nut gauge, as described in Appendix IV., combined with inside and outside diameter gauges.

The Committee, in printing the two tables, for which they have to thank Mr. Le Neve Foster and Mr. Price, do not take the responsibility of recommending any limits, but publish the information as an indication of the limits of accuracy to which these screws may be expected to be produced in practice.

If the recommendations of the Committee be approved of they further recommend that the Committee should be reappointed for the purpose of obtaining and verifying standard combs and male screws, and determining the future home of the gauges.

(To be continued.)

TESTS OF 300 H.P. DE LAVAL TURBINE.

Electricity (New York) publishes the following table of the tests recently made with the 300 H.P. De Laval turbine of the Edison Company, of New York. The whole space occupied by the turbine, gearing, and dynamos, measures only 4·05 m. × 1·97 m. × 1·32 m., the turbine running at 9,000 revolutions and the dynamo at 750 revolutions, the turbine disc having a diameter of 29½ inches and a breadth of only $\frac{4}{10}$ths inch.

The special point emphasised by our contemporary is the comparatively small increase of steam consumption for light loads, small, that is to say, as compared with the 50 lbs. used by a compound Corliss condensing engine or the 40 lbs. of a triple expansion, the percentage of full load being 18·5. But there is another important factor. Ironclad armatures can be run at enormous peripheral speeds, and therefore small dynamos at high speeds could be employed with steam turbines to replace the present great multipolar slow speed machines, all which means less copper, less iron, less space, and therefore less fixed charges, and generally less expense in buildings and heavy overhead cranes. The use of steam in the form of a free jet differs but little from that of the similar employment of the free jet or Pelton wheel. The Pelton wheel marks a departure from the rut of the guide blade idea, exactly parallel with the De Laval system of steam turbine. This system must not be confounded with that of the Parsons wheel. In the latter, steam is used at pressure, and it loses pressure in its passage through the wheel. In the De Laval system the steam is expanded in the nozzle, and acts simply by impulse. In a free jet any pressure above that of the atmosphere would be impossible, for it would cause the jet to spread and break up. Strictly speaking, therefore, the steam exhausted by a De Laval wheel ought to escape with a velocity in the direction of the axis of revolution only, and measured by the tangent of the splay angle of the vanes, the peripheral speed of the wheel being theoretically half the tangential flow velocity of the steam jets. The losses which are unavoidable are those of eddying, friction, and the more obscure effects of elasticity of the steam itself, whereby the full effect of impulse cannot be transferred to the wheel. These added to the losses arising from insufficient peripheral speed and to residual axial velocity, are no doubt serious, but there is none of that loss so serious in piston engines which arises from cylinder condensation, and the future of the steam turbine seems bright. It can hardly suffer from the deterioration of age, except so far as the steam may have a cutting action, which it undoubtedly has where there is any carrying over of lime salts by the steam. These are well known to exercise cutting effects on valve spindles where exposed to direct impingement of a steam jet.

Test of Steam Turbine When Operated with 2, 4, 6, 7 Jets.
(One Hour Duration Each Test.)

April 3rd, 1896.

No. of jets used.	Average load.		Average watts.		Per cent. of full load.	Vacuum	Lbs. of steam per E.H.P.
	Amp.	— Amp.	+	—			
2	153·78	147·15	18 707	18 283	18·50	27·	27·35
4	433·60	455·80	54 156	57·886	56·02	26·43	20·22
6	700·85	718·65	87·746	91·268	89 51	26·07	19 75
7	771·94	787·33	97·418	100·856	99 14	25·79	19·95

The further success of the jet turbine is entirely one of form and mechanical strength and speed. The tests of two observers on April 2nd last, when averaged, show a voltage of 127·25, and a capacity of 692·48 amperes on the + side, and of 128·26 volts and 709 18 amperes on the − side. This runs out to a mean H.P. of 266·72 for a six hours' run, or 1,600·32 H.P. hours. For this period the air pumps discharged 27,763 lbs. of water, and the steam per B.H P. hour was 17·348, that per E.H.P. being 19·215.

An interesting problem suggests itself in regard to the working of a non-condensing steam turbine of the jet variety. Discharging at atmospheric pressure, and the jet velocity being probably greater than the attainable peripheral velocity, would indicate as a desirable jet velocity, would it not be possible to reduce the velocity of the steam jet by mixing with it a proportion of water from the boiler, which would be promptly returned to the boiler? A mixture of an equal weight of water would exactly halve the jet velocity and bring it nearer to the practicable vane velocity. The steam would lose its velocity, but the jet would have a double weight, and there would be reduced residual losses. The injector for boiler feeding acts exactly on these lines. A given weight of steam is mixed with several times its weight of water, and the final velocity of the resultant combined jet is less than that proper to steam flowing from the boiler to a partial vacuo in the ratio of the mixture, varied, of course, by eddy and friction losses. An injector is a heat engine working between boiler temperature and jet temperature, and could be made to work a Pelton wheel; but it would be exceedingly wasteful. The suggestion made above does not suppose that any steam is condensed by the water, but that the two travel together as a water laden slower moving steam jet, and any benefit to be derived would be purely mechanical, and due to the ability to better utilise jets of low velocity. In some French trials of De Laval turbines this point is borne out, for the best results were obtained with the highest peripheral velocities.

Tests made at the Edison station were adverse to the working of the turbines non-condensing, and Unwin is quoted as showing the velocity of 75 lbs. steam flowing to the atmosphere to be only 2,625 feet per second, whereas if flowing to a vacuum of 1½ lbs. above absolute, the velocity is 4,600 feet.

Excepting the indications of the French tests that the limit of peripheral useful velocity has not been attained, we do not remember to have seen anything dealing with the correct ratio of velocity of wheel to that of the turbine; but our impression is that the attained velocities are too small to utilise the energy in the steam.

THE POTENTIAL OF STEAM.*

By HOWARD PENTLAND, B.A., F.R.I.B.A., M.Inst.C.E.I.,
Royal Hibernian Academician.

The partnership between steam and electricity is every day becoming closer. It is not very long since huge low speed engines and endless vistas of shafting and belting were thought to be the acme of power distribution, but the high speed engine wrought a great change in opinion, and in many cases it has been found more economical to bring about the steam from one or more boilers to small directly coupled engines. The steam dynamo has now wrought another change, and even for short distances it is being found economical to bring about the electric current to small motors coupled directly to fans, capstans, winches, lifts, machine tools, and washing machines. This has mainly been brought about by the almost perfect efficiency of the modern dynamo and motor, by means of which brake horse-power may be converted to electrical horse-power with a loss of 5 per cent., delivered 100 yards off with a loss of 1 per cent., and reconverted to mechanical horse-power with another loss of 5 per cent. Now, if we discuss with a central station engineer the theory of the most advanced form of steam dynamo, say a large Sayer's patent continuous current shunt wound machine, with an efficiency of about 95 per cent., driven directly by a Willans patent central valve compound engine, with an efficiency of about 90 per cent., giving a combined efficiency of about 85 per cent., it will be observed that he uses two languages, the foot-pound-second language on one side, and the centimetre-gram-second language on the other side of the fly-wheel. Bring him to one end of the common bed plate and he talks of horse-power, foot-pounds, pounds-per-square-inch, and British thermal units. Bring him to the other end and he talks of watts, joules, volts, and calories.

A constant stream of energy flows through the steam dynamo from the boiler. The energy of the coal is converted into the energy of the steam, the energy of the steam into the energy of the shaft, and the energy of the shaft into the energy of the electric current. Not only, however, does the unit of energy-measurement change at the last conversion, but the very principle of measurement on which the unit is based. However desirable, therefore, may be the substitution of the centimetre and the gram for the foot and the pound, a course I have no intention of now advocating, although the kilowatt is slowly but surely driving the horse-power out of the modern specification, it leaves the main evil untouched. Energy or the capability for work is measured in respect of quantity on the same principle on both sides of the fly-wheel, but in respect of degree on three different principles! It stands to reason that whether it be desirable to adopt the centimetre-gram-second system or not, it is, at all events, desirable to have a common principle of measurement throughout, not alone for the energy which goes in through the furnace door or the steam port and comes out through the brushes, but for its *degree or potential*.

The potential of both coal and saturated steam is now estimated in British thermal units per pound, the potential of the expanding steam in pounds-per-square-inch, and the potential of the electricity in volts—in fact, by heat pressure and *work*. Why not by *work* throughout?

The idea of potential has, up to the present, been monopolised by electricians, and my object is to show that they have no exclusive right to it, and that the sooner steam users awake to the fact that it is a general conception which is no more concerned with electricity than with steam, water, coal, the luminiferous ether, dynamite, beef, or any other substance whose energy, temporary or constant, ministers to our needs, the clearer will be their mental vision, and the less their mental labour in the domain of energy, work, and power. For many years men have reasoned about the pressures of water, steam, and air, the level of lakes, the run of clock weights, the loudness of notes and noises, the temperature of gases, the candle-power of lamps, and the velocities of projectiles, and they have recognised that although these things require distinct measurement by foot rules, gauges, thermometers, photometers, phonometers, ballistic pendulums, and the like, they are manifestations of the one thing whose common measure is work—namely, energy, or the capability for work. But while they have recognised this they have failed to see that although steam and electricity are incommensurable in respect of quantity, the degree of energy or potential which they possess may be measured, if not by the same unit by a unit based on the same principle, which in each case shall bear the same relation to the unit of quantity as specific gravity to weight, or specific heat to total heat.

A specific amount of anything is the amount possessed by the unit quantity. Specific gravity is the weight of the unit volume. Specific heat is the quantity of heat gained by the unit mass when its temperature is raised by 1°. Specific resistance is the resistance of the unit volume in the form of unit length of unit sectional area, &c. The specific cost of tea is its price per lb. The specific quantity, as its name implies, enables us to specify the *degree* in which any quality, such as weight, heat, resistance, price, &c., is possessed by the unit volume or the unit mass of any material, be that material ponderable like steam, or imponderable like electricity. Given the specific amount of the quality or the amount possessed by the unit, we at once find the total amount by multiplying it by the number of units of volume or mass. For example, we are told that the specific gravity of aluminium is 2·5—that is to say, 1 cubic centimetre of aluminium weighs 2·5 grams, or aluminium weighs 2½ grams-per-cubic-centimetre, and we find the weight of 20 grams by multiplying this by 20. Now, *potential is specific energy, or specific capability for work, or the capability*

* A paper read before the Institution of Civil Engineers, Ireland.

of the unit quantity for work. We measure steam by pounds, and therefore the potential of steam is the capability of a pound of it to do work, and is measured by the number of foot-pounds that a pound can do. Its mechanical unit in the foot-pound-second system is the *foot-pound-per-pound*, but all matter cannot be measured by pounds. We believe—I might almost say we know—that the whole of the visible universe is full of ether possessing capability for work to the extent of millions upon millions of foot-tons, the ether which conveys the light and heat of our own and many other suns. We believe that electricity is ether, and we measure it by coulombs and its rate of supply by amperes or coulombs-per-second, just as we measure steam by pounds and its rate of supply in pounds-per-hour. When a man asks me what a coulomb is, I ask him what a pound is, and I generally find that he doesn't know! However desirable, it is not absolutely necessary to know more about coulombs than we know about pounds.

A pound of water in the Stillorgan reservoir can do about 100 foot-pounds of work, some in Dublin and some on the way—more on the way than is pleasant to contemplate; its potential is, therefore, 100 foot-pounds-per-pound. A pound of steam in one of the Babcock and Wilcox boilers in the electric lighting station of the Dublin Corporation can do nearly a million foot-pounds of work, some in our lamps and some on the way—more on the way than is pleasant to contemplate; its potential is, therefore, a million foot-pounds per pound. One coulomb of electricity as supplied by the Dublin Corporation transformers can do 100 joules, or 73⅔ foot-pounds, of work; its potential is, therefore, 73⅔ foot-pounds-per-coulomb. But electricians have a rooted objection to compound units, and instead of saying 100 joules-per-coulomb, they say 100 volts—the *volt* being a name for the *joule-per-coulomb*, the electrical potential unit in the centimetre-gram-second system. I do not, however, advocate any single name for the foot-pound-per-pound. The compound name is not very cumbrous, and any suitable name should be reserved for the steam potential unit of the future, the practical centimetre-gram-second unit or the *joule-per-gram*. How distinct would be the links in the chain of energy when a current of so many grams of steam per second, at a potential of so many joules-per-gram, was shown to be converted by a steam dynamo into a current of so many coulombs of electricity per second (or amperes), at a potential of so many joules-per-coulomb (or volts).

It must be recollected that neither energy nor potential are work, they are capabilities for work—the one *general* of a number of units, the other *specific* of a unit. They are *measured by, but are not,* work. A joule is equal to ·7373 foot-pound, and a pound is equal to 453·593 grams. A *joule-per-gram*, or the centimetre-gram-second steam potential unit is, therefore, equal to 334·434, or, say, 334½, foot-pounds-per-pound, or foot-pound-second steam potential units.

It is an extraordinary fact that, although work per unit is the true measure of potential, there are no less than seven measures and *quasi* measures of potential in use, namely:—(1) *Height or level* in feet, as in the case of water or clock weights; (2) *pressure* in pounds-per-square-inch, as in the case of water, air, or steam; (3) *quantity of heat* in British thermal units, or in calories, as in the case of fuels or saturated steam; (4) *temperature*, as sometimes in the case of steam in degrees F. or C.; (5) *mechanical work* in foot-pounds or in joules, as in the expansive use of steam; (6) *electrical potential* in volts, in the case of electrical currents and condenser charges; and (7) *lucic intensity* in luxes, in the case of light. No one, however, has as yet attempted to measure sound potential, so we are probably delivered from an eighth!

The ideal of potential is not the only one that has been monopolised by electricians. Most people think that the circuit is a peculiarly electrical idea; but there is a steam circuit as well as an electrical one. There is, in fact, a circuit whenever work is being done, the circuit being the path of the electrical, gaseous, liquid, or even solid *current*, whether of electricity, steam, water, or ropes. A circuit consists of two parts—the *internal*, in which the potential is raised, and the *external*, in which it falls. In all circuits exactly the same quantity of matter, but not necessarily the same matter, as leaves the positive reaches the negative pole, whether there be leakage or not. The internal circuit consists of an apparatus for raising potential, a battery, a dynamo, a transformer, a steam boiler, a pump, or a winding engine. The external circuit consists of the several apparatus in which the potential falls, as the current or rope does work lamps, electric motors, steam engines, or feedwater heaters, and the connecting pipes or cables. Work is done upon the current in the internal; it does work in the external circuit, and returns whence it set out, incapable of more work, until raised in potential it once more sets forth on the same journey. Zero potential is an arbitrary point, like Ordnance datum, or Trinity high water mark, the usual zero being the lowest potential in the circuit, that at the negative pole, which is frequently the level temperature or voltage of the earth. The positive pole is the end of the internal circuit of highest, the negative of lowest potential, the delivery and suction in the hydraulic; the steam chest and the exhaust pipe, or indeed the atmosphere in the steam circuit. The resistance of a circuit is that which reduces potential by the development or escape of heat, electrical resistance, friction, condensation, &c., and is measured by loss of potential per unit quantity per second. An ohm is properly defined as unit loss in electrical potential per coulomb per second—that is to say, a volt-per-ampere, or a joule-per-coulomb-per-coulomb-per-second, and the corresponding unit of steam pipe resistance is unit loss in steam (and water) potential per pound per second—that is to say, a foot-pound-per-pound-per-pound-per-second—a very simple expression, were the names of some of the past Presidents of this Institution embalmed in the names of the units of steam, as those of Volta and Ampère are embalmed in those of electrical, potential and current. Lagged steam pipes are the time-honoured instruments of power distribution on shipboard; but leaky joints, waste of space, corrosion, expansion, and contraction and condensation, and a host of minor evils, are convincing shipowners that the days of steam distribution are numbered, and that electric cables must be substituted. The drop of electrical potential need not exceed 1 per cent. in 100 yards, while the drop of steam (and water) potential in the same distance is usually from 10 to 20 per cent. Is it too much to hope for the advent of a *steam ohm*, even although I am obliged to derive it in the benighted foot-pound-second system, and to call it provisionally the *foot-pound-per-pound-per-pound-per-second?* Such comparisons seem to demand it.

Ohm's law, which states that resistance is the ratio of potential to current, is thus seen to be as true of steam in a copper pipe as of electricity in an India-rubber pipe.

It is true that electricity is not liable to condensation, but the definition of resistance given includes the cause of condensation, and shows that the sudden drop of potential accompanying it may be treated exactly as a shunt circuit of high resistance from the point where it takes place to some point whose potential is near if not at the lowest potential of the circuit. Condensation, in fact, is a short circuit to the exhaust, whether the condensed water is drained off, runs back to the boiler, or wets the steam in the cylinder.

The potential of saturated steam, or of water in a Halpin steam storage tank, at any temperature or pressure, may be ascertained at once by multiplying the total heat from the zero in question, that is to say, the temperature of the water supply not of the feedwater, for the feedwater heater in which the steam potential falls is a part of the external circuit—by Joule's equivalent. We wish to know, for example, the potential of saturated steam at a pressure of 100 lbs. on the square inch, with the water at 50°—say the temperature of the earth. We take the absolute pressure, say 115 lbs., and find from a table of the properties of saturated steam that the total heat above 32° F.—that is to say, the sum of the heat required to raise water from 32° F. to the boiling point corresponding to the pressure named, and the latent heat of evaporation at that temperature is 1,184·5 British thermal units. But if the water be supplied at 50°, or 18° higher than 32°, this total heat is 18 thermal units too much, and should, therefore, be 1,166·5 thermal units. But a thermal unit is equivalent to 772 foot-pounds, and therefore the required potential is 1,166·5 × 772 or 900,538 foot-pounds-per-pound. As the total heat of saturated steam is nearly constant, increasing very slowly with the pressure, it follows that its potential, which may be taken at about 900,000 foot-pounds, or about 400 foot-tons per pound, is so also. Neither the temperature nor the pressure, therefore, of saturated steam are practical factors in its potential, but the potential of superheated steam, and of steam worked expansively—the form of steam with which the recent great advance in compound engines is concerned—depends *cæteris paribus* on its temperature or its pressure. When the steam current, or the rate at which steam is being supplied, say in the cylinder, is known, the rate at which work is being done in the cylinder is known, for the product of the steam current by the difference of the potentials of the steam, or the compound of steam and water which it becomes, as it enters and leaves the cylinder, gives the power required to work the piston in foot-pounds-per-second, or 550ths of a horse-power, just as the product of the electric current by the difference in the potentials of the electricity as it enters and leaves the lamp gives the power required to work the lamp in watts or 746ths of a horse-power. *The indicated horse-power is therefore the product of the difference of the potentials of the steam as it enters and leaves the cylinder, by the steam current*, and a comparison with the brake horse-power will at once give the drop of steam potential which is the measure of the mechanical efficiency of the engine.

The ideas of energy, work, and power which have proved so useful in the electric current, would, therefore, seem to be equally applicable to the steam or any other material current where potential runs through its cycle of changes. That these ideas afford the simplest means of dealing with these cycles of changes stands to reason, when we reflect that they arose amidst all the advantages of improved quantitative methods, and in the absence of both of an electrical sense and of a measure of electrical quantity analogous to weight as a measure of mass. The calculations that deal with the work of steam arose when quantitative methods were much less precise than now, and the phenomena that evoked them comparatively simple; but exhaustive as they now are, I cannot but feel that all those who are concerned with them, especially those—an increasing number—who are also concerned with electrical calculations, would feel their grasp strengthened and their views widened by the gradual adoption of a more uniform system. The great problems of steam expansion which have resulted in the Willans, Westinghouse, and other high-speed compound engines are directly concerned with the work done by the unit weight of steam present at the cut-off. This idea of steam potential is therefore growing, and potential tables will doubtless be provided before long; but an architect cannot speak *ex cathedrâ* on such a subject, and I commend its consideration to those whose daily work brings them more in contact with the expansive use of steam than mine can possibly do, asking them to recollect that on the one hand steam engineers have unconsciously adopted the idea of potential in expressing the calorific value of fuels in British thermal units per pound, and that on the other hand the horse-power have even now to reckon with the kilowatt.

(To be continued.)

INTERNATIONAL SUBMARINE TELEGRAPH MEMORIAL.

The following correspondence has appeared in the *Times* during the past few days:—

Sir,—The names proposed to be associated with the contemplated memorial of submarine telegraphy—Field, Pender and Anderson—

are certainly well and worthily chosen. But I see no mention, in your report of yesterday's proceedings, of one of the first to originate, if not the true originator of submarine telegraphs, the late Mr. C. V. Walker, F.R.A S., telegraph engineer of the South-Eastern Railway.

Mr. Walker, on January 10th, 1849, carried out to sea from Folkestone two miles of covered wire, and through the insulated conductor, thus submerged, held telegraphic conversation with his chairman in London from the deck of a vessel afloat.

This was the birth of ocean telegraphy.

F. E. Baines, Sometime Surveyor-General (Telegraphs), G.P.O.

Bournemouth, *October 7th.*

Sir,—A letter from Mr. F. E. Baines in your issue of the 8th inst. calls attention to the valuable work done by the late Mr. C. V. Walker, F.R.S., in 1849.

It is advisable, however, to draw some distinction between undertakings of this nature in shallow water, and the laying of a long length of cable across the ocean in a two-mile depth, where, moreover, a much greater amount of capital is involved.

Otherwise we are taken back to the early experimental performances in 1838, of General F. C. Pasley, R.E., in the river Medway; secondly, to those of Sir William O'Shaughnessy Brooke, a year later, across the Hugli; thirdly, to those of Werner von Siemens in the Rhine about the same time.

Charles Bright.

Sir,—I understand that it has been found desirable to create a memorial to submarine telegraphy, and that the late Sir John Pender, Sir James Anderson, and Cyrus Field have been chosen to represent this highly scientific department.

Apart from the humour of the thing, it seems to me that this selection of names is a gross injustice to the real workers in the field. I am sorry to find myself entirely at issue with Lord Selborne in his opening speech on Tuesday. Had he made reference to any impartial authority he would have been more accurate in his statements.

To my knowledge, Sir James Anderson's only connection with submarine telegraphy, from the technical pioneer point of view, was as captain of the merchant ship *Great Eastern*, when engaged on the laying of the second and third Atlantic cables.

There must be many like myself who can testify to the fact that, in the light of an engineering enterprise, Sir Charles Bright and Sir Samuel Canning were the responsible parties, as regards the various early Atlantic cable expeditions of 1857, 1858, 1865, and 1866. Like myself, Lord Kelvin was on board, and should be able to bear me out in this.

Many are said to have laid the Atlantic cable, but, in reality, Bright and Canning had the work on their shoulders in the above undertakings.

Besides those named here in connection with the Atlantic cables, there were, of course, many scientific gentlemen associated with other submarine lines.

Henry A. Moriarty, Captain R.N., C.B.

Sir,—Lord Selborne's address to the Committee would lead anyone to suppose that Sir James Anderson had laid the second Atlantic cable. This is an error. Sir Samuel Canning was the engineer in charge of the expedition; and upon him alone rested the responsibility of the undertaking.

In point of fact, the main feature of this expedition was the recovery of the 1865 cable. The possibility of laying a cable in deep water had been previously demonstrated by the late Sir Charles Tilston Bright in connection with the first Atlantic line; but it remained for Sir S. Canning to prove that a cable could be picked up in the Atlantic, and to him alone all honour for this is due.

A special application was made to the Admiralty for a navigator both as regards the first and second Atlantic cable expeditions; and in each instance Staff-Commander Moriarty, R.N., C.B., was deputed for the purpose, much to the credit of that Department.

Sir James Anderson was the captain of the *Great Eastern*, but in no way responsible for the cable operations.

With reference to the first Atlantic cable, Mr. Cyrus Field came over to England to raise the necessary capital; and, undoubtedly, much credit is due to him for his indomitable energy and perseverance.

Sir John Pender acted in a similar capacity in the further extension of submarine telegraphs.

But certainly all the three names pressed forward in the proposed memorial are those of commercial men rather than of engineering pioneers in this great engineering work.

Henry Clifford, Assistant Engineer to Sir C. Bright, First Atlantic Cable; Assistant Engineer to Sir S. Canning, Second Atlantic Cable.

Sir,—Your correspondents of to-day have raised some question as to whether, in celebrating the jubilee of submarine telegraphy by a memorial, honour should be paid exclusively to commercial to the exclusion of scientific pioneers. Those who (unlike Lord Selborne) really know the early history of cable telegraphy, know that the true pioneers were such men as Mr. Jacob Brett, Mr. C. V. Walker, Sir Charles Bright, Sir Samuel Canning, and, most celebrated of all though not earliest, Lord Kelvin. It was the demonstrated successes of these pioneers that rendered possible the subsequent financial operations of such men as Sir John Pender and Mr. Cyrus Field.

No doubt the laying of submarine telegraphs to connect together the most distant parts of the globe has been one of the greatest triumphs of science in the Victorian era. It is well and fitting that such triumphs, wrought almost exclusively by the efforts of British pioneers, should be made the subject of a jubilee memorial. But if the names of any persons are to be associated with such a memorial, surely the utmost care should be taken to select the right names.

There is an ominous note in the letter which Lord Kelvin addressed to the Marquis of Tweeddale excusing himself from attending the meeting at Winchester House on 6th inst. for the promotion of the memorial. In that letter, since published *in extenso* in the *Electrician* of October 9th, p. 771, Lord Kelvin speaks, perhaps unintentionally, of "the Pender Memorial."

In the face of these circumstances it is not inopportune to ask the following question:—Is this submarine telegraph memorial going to be a memorial to the growth of submarine telegraphy or to the greatness of Sir John Pender and of the gentlemen associated with him in the financial development of the cable companies?

I am, Sir, your obedient servant,

Omega.

[A number of other important letters on this subject have also appeared in the *Times* and the *Morning Post*, but pressure upon our space prevents us publishing them this week.—Eds. Elec. Rev.]

CORRESPONDENCE.

Measuring Instruments.

In your issue of September 25th, you refer to tests made by Prof. Jamieson on my shielded meters.

Referring to the temperature error (which, as you say, Prof. Jamieson found negligible) you give this as a $\frac{1}{4}$ to 1 per cent.; this should, however, read: "The temperature error is also negligible, being only $\frac{1}{4}$ of 1 per cent. at 100 volts, after 20 hours in circuit."

May I add that since the above tests were made I have been able to completely eliminate the temperature error; all my voltmeters are now wound to a resistance of 50 ohms × the maximum reading in volts, but where desired this resistance can be almost doubled; the instrument is therefore extremely useful as an ohm-meter when graduated in ohms, and can be used by any man capable of reading a volt or ammeter.

W. McWhirter.

Alternate Current Station Switch Gear.

I have read with much interest the description of Mr. Andrews's alternate current switch in your last issue.

Doubtless, as Mr. Andrews says, the operation of switching in a second machine is a very delicate matter, but when he further states, *vide* the *Engineer*, that only one member of the staff could previously be relied on to perform this operation, he rather gives the Hastings staff away!

Perhaps, now that the position of the switchboard attendant is fully realised, the following lines discovered in an electric light station will be appreciated:—

The Young Synchroniser.

With quiv'ring knees, strain'd eyes
And cold perspiring hands,
Amid the whirl and hum
Of alternators, wheels,
And throbbing cranks, behold!
The young synchroniser.
In eager haste he grasps
The massive bolt, and waits—
And waits——and waits; meanwhile
His courage ebbs and flows,
As current fails or grows
In lamps that phase disclose.
His judgment lags. At last,
A pause——the chance has gone,
Ill fated youth, too late.
Heavens! he strikes—too late.
. . . . . .

(*Soft music from the alternators*)

While on the subject of parallel running, a *true* story from an American station may be of interest. It happened that the synchronising lamp connections were reversed when the switchboard was erected, consequently the machines were switched in, dead out of phase every night for about six months, without any serious trouble. (N.B.—They were American built machines.)

The return current switch, however, is badly wanted, and possibly when combined with the exquisite elaborations of interlocking handles already designed, the central station may be efficiently run by the time honoured gardener—who tends the gas engine and accumulators.

J. R. Blaikie.

Bristol, *October 12th*, 1896.

In the interesting article under this heading in your issue of the 9th inst., which deals chiefly with the switch gear of the Hastings Electric Light Company, the Andrews automatic cut-out is described; but from this description it is not clear to me why any but a fraction of the current passes through the series coil of the controlling relay.

Each alternator has one terminal earthed (E, fig. 1), this same terminal being connected to the earthed outer bus bar through the series coil of the relay. The latter is, therefore, shunted by the earth plates, and the amount of current it receives depends on the relative conductivities of the two circuits. It is, therefore, possible that a non-synchronous alternator could receive a large current through its earthed terminal without this passing through and actuating the relay.

How are these earths made? are they of high resistance? and if not, why is the current to or from the machine bound to pass through the relay?

Why is it necessary to earth separately one pole of the alternator, as in fig. 1, when the same is connected to an earthed bus bar and feeders?

Then, is there any reason why the shunt coil is wound differentially! would not one winding on one end of the bobbin in connection with the series winding and a spring do equally well, and be simpler for adjustment?

I should be glad if the writer would make these few points clear.

T. R. D. Kenny.

The Hookham Meter.

We note that your issue of the 9th inst. contains a short article on the new Hookham alternating meter. This article contains curves showing its performance, and, further, a comparison is made with the performance of its predecessor, pointing to some, but by no means to the whole, of the improvements effected.

As the report does not emanate in any way either from our principals or ourselves, it must be clearly understood that we are not prepared to accept certain of the writer's criticisms.

On the whole, however, its substance points to an extensive experience and accurate knowledge of the meter, and, as a purely independent criticism, may be regarded as decidedly favourable.

Venner & Sillar.

Concentric Cables.

Mr. Hetherington's remarks are interesting, but when he offers to "point out some misconceptions into which I have fallen," I must ask you to be good enough to allow me a few lines in reply.

I know of cases—one in particular—where the tender for rubber cables was a lower figure than that asked for compound cables of equal quality and to the same specification.

Of the stations opened in 1896, several employ rubber cables largely, and two solely.

Therefore, rubber still competes with success against compound insulation, and sometimes beats it in respect of price.

The Board of Trade say:—

"Where the conditions of the supply are such that the pressure may at any time exceed 500 volts if continuous, or 250 volts if alternating, but cannot exceed 3,000 volts, whether continuous or alternating, the supply shall be deemed a high pressure supply."

Therefore, a three-wire 200 or 220-volt system with alternating current would be classed as a high pressure supply.

With reference to the breaking-up of streets, I think Mr. Hetherington forgets that sections in provisional orders relate to "alterations of pipes, wires, &c., under streets," and "laying of electric lines, &c., near gas or water pipes or other electric lines." Many of these are binding on both the undertakers and the owners of other pipes and lines laid underground. It is customary in practice for gas and water companies to serve a notice of their street openings upon the undertakers, in the same way that the undertakers treat them, and in this way all parties carry out the spirit of the sections of the provisional order. A builder is not under such obligations, however; but even he is affected by local bye-laws, and if the local vestry, County Council, or municipal authority be on reasonably friendly terms, arrangements can be made to obtain notice of street works, although in some cases such notice is not imposed by statute upon the parties likely to interfere with underground mains.

Lastly, if Mr. Hetherington will refer to your first issue in March of the current year, he will, if I remember aright, find a reply to the last paragraph of his letter.

The Writer of the Article.

October 7th, 1896.

The National Memorial.

The two letters I send you to-day* have been written during my absence from town, and without my knowledge. It is hopeful, however, and they are a sign of the widening of the memorial question.

Although this is an age when people are fond of running up memorials more or less useless, it is just as well to endeavour to obtain funds from the general public (I am sure many telegraph people do not relish this) for a purpose which will balance with common sense.

Such a line I am told by many might be got by following the article in the Electrical Review of September 18th. One name, that of Sabine, should appear after that of C. W. Siemens at page 359.

Writer of the Article.

London, *October 14th*, 1896.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Oct. 13th, 1895.	£	s.
Algoa Bay	62	0
Bombay	20	0
Boulogne	10	0
Brisbane	40	0
Brussels	766	0
Buenos Ayres. Teleg. material	2,459	0
Calcutta	800	0
Cape Town	185	0
Colombo...	95	0
Copenhagen. Teleg. wire	75	0
Delagoa Bay	34	0
East London	129	0
Gothenburg	16	0
Hong Kong	85	0
Melbourne. Teleg. mtl.	298	0
Monte Video	16	0
Montreal	64	0
Rangoon	40	0
Rotterdam	8	0
Santos	117	0
Shanghai	21	0
St. Petersburg	45	0
Singapore. Teleg. mtl...	411	0
Sydney	65	0
Toronto	49	0
Wellington	238	0
" Teleg. mtl.	785	0
Yokohama	35	0
Total	£6,968	0

Week Ending Oct. 13th, 1896.	£	s.
Amsterdam	160	0
Antwerp...	150	0
" Electric fuses	670	0
Auckland	46	0
Beira. Teleg. mtl. ...	1,300	0
Bilbao	80	0
Bombay	18	0
Brussels	362	0
Calcutta...	326	0
Cape Town	527	0
Colombo...	118	0
East London	2,059	0
Flushing	21	0
Fremantle. Teleg. mtl.	155	0
Hamburg. Teleg. mtl.	280	0
Hong Kong	309	0
Kilindini. Teleg. mtl....	4,745	0
Lisbon	500	0
Macca. Teleg. mtl. ...	32	0
Melbourne. " " ...	62	0
Nelson	38	0
Pesth	720	0
Port Elizabeth	108	0
Porto Alegre. Teleg. mtl.	30	0
Shanghai. Teleph. mtl.	23	0
Singapore " "	22	0
Stettin	50	0
Stockholm. Teleg. mtl.	171	0
Sydney	589	0
Tientsin...	327	0
" Teleg. mtl. ...	126	0
Vigo. Teleg. cable	83,000	0
Wellington	225	0
Total	£97,379	0

Foreign Goods Transhipped.

	£	s.
Rockhampton	80	0
Stockholm. Teleph. mtl.	27	0
Total	£107	0

A Handy Pocket-Book.—The 1896 pocket price list of the Electric Construction Company, Limited, is an exceedingly neat and very handy little book, bound in limp leather covers with gilt lettering. About half the pages of the book deal with the company's manufactures, *i.e.*, dynamos, transformers, motors, switches, switchboards, and smaller accessories. The other half consists for the most part of memoranda sheets arranged with finger index. The last few pages of the book contain tabulated and other useful informa-

* The letters referred to are those which appeared in the *Times*, which we reprint elsewhere.—Eds. Elec. Rev.

tion, such as dimensions of copper wires, stranded cables, rules for finding dimensions of belts, diagrams showing types of magnet winding of dynamos, suggestions as to management of high tension dynamos and motors, &c.

Bankruptcy Proceedings.—The *London Gazette* contains notice of the release, dated September 17th, of the trustee (Harold W. Cox, Official Receiver), in the matter of Woilliard, Scarborough and Co., electrical and mechanical engineers, Wade Street, Halifax.

Dissolutions of Partnerships.—Messrs. Conze & Simon (W. E. Conze & P. F. W. Simon), electrical engineers, of 52, Queen Victoria Street, E.C., have dissolved partnership. All debts of the late firm will be attended to by Mr. Simon, who will carry on the business under the same name as formerly.

Messrs. G. J. S. Lock, H. M. Lock, and E. C. H. Tiffin, hitherto carrying on business at 17, Berners Street, London, W., under the style of Moutrie & Co, electrical engineers and manufacturers of electrical fittings, have dissolved partnership. Mr. G. J. S. Lock will attend to debts, and will continue the business under the old style.

Liquidation Notices.—A meeting of the Val D'Aosta Electric Power Company will be held at 32, Victoria Street, London, S.W., on Wednesday, November 11th, at 5 o'clock, for the purpose of hearing an account of the winding-up by Mr. A. L. Snowdon, the liquidator.

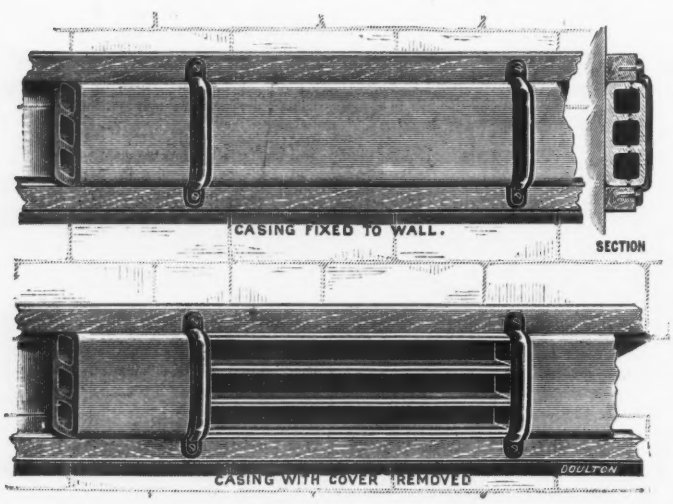
Catalogue.—A catalogue has been sent to us by the Stewart Electrical Syndicate, Limited (who are the agents for the J. H. McEwen Manufacturing Company, of New York), which contains some particulars of dynamo-electric machinery manufactured by the company. The printed matter deals with the history of continuous current generators, and describes the Thompson-Ryan dynamo in great detail. The illustrations are about as excellent and as effective as anything we have seen in a catalogue, particularly those showing the various departments of the McEwen Company's works, the Thompson-Ryan generator direct connected to McEwen engine, the McEwen tandem compound engine direct connected to Thompson-Ryan generator, and the Thompson-Ryan belted dynamo. An efficiency curve of this dynamo is given.

Changes of Address.—Prof. A. B. W. Kennedy announces that in future the address of his offices will be 17, Victoria Street, London, S.W.

The Birmingham Installation Company has removed from 28, Broad Street, Birmingham, to 18, Arcade Chambers, Corporation Street.

Concentric Wiring.—Messrs. Mavor & Coulson, of Glasgow, have sent us a list devoted to the "C.C." concentric wiring system. A number of cuts and a good deal of letterpress matter explain the system and describe junctions, distribution fuse boxes, switches, &c. A number of testimonials are given. Mr. C. R. G. Smythe, of 12, Idol Lane, E.C., is the sole London representative.

Interior Casing for Electrical Cables.—This casing, which is made of strong glazed stoneware, is claimed to be specially suitable for use in electric supply stations, or in other situations where electric cables of large capacity have to be carried inside buildings. This casing has three ducts, each 1 inch by 1 inch. During manufacture, a partial division of the substance is made longitudinally, leaving sufficient material to preserve strength. By means of a chisel the upper portion may be at any time detached. The two portions need not be separated until access to the cables is required. The illustrations show one method of fixing. The casing is placed between two wood fillets, and the lengths are held in position by small cast-iron clips. Inspection of the cables can be made at any point by removing a clip and detaching the cover of one of the lengths. Buried in cement or concrete, this casing forms a permanent conduit in walls or ceilings. Messrs. Doulton & Co. are the manufacturers.



Gas.—An explosion of gas occurred in Main Street, Govan, on 7th inst., severely injuring a man who was seeking for an escape.

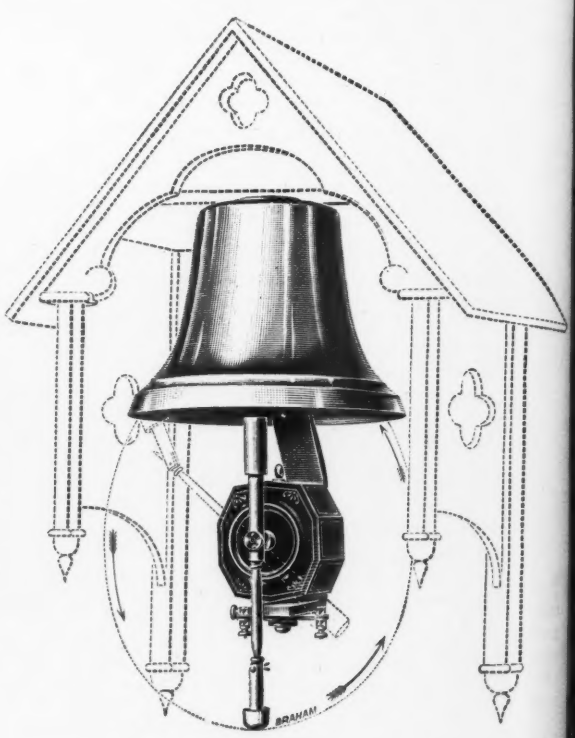
A gas explosion at Graham's Terrace, Wakefield, on 24th ult., resulted in the death of a coal merchant, from burning.

Gas explosions at a Stratford public house almost wrecked the lower part of the premises, and two people were injured.

A serious gas explosion occurred on Tuesday morning at the Central Hotel, Douglas.

Messrs. Parsons' Catalogue.—A well bound and excellently printed catalogue has been issued by Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne. Messrs. Parsons, as is well known, make a speciality of heavy electrical engineering work, such as central lighting station and transmission of power plant, electric mining machinery, fans, condensers, engines, and especially steam turbines. The book opens with some general comments on "The Ideal Engine," followed by lengthy remarks on the compound steam turbine, illustrated by sectional views of the radial flow turbine, and the parallel flow turbine. Notes are given on the advantages of the steam turbine, also sketches and prices of compound steam turbines, jet and duplex jet, and surface condensing plant. Turbo-electric generators are dealt with in a separate chapter, and in connection therewith are described and illustrated steam turbine unipolar dynamos, turbo-alternators, &c. Vertical engines and dynamos, transformers, street boxes, electric locomotive for light railways, electric hoist, steam turbo fans for collieries, factories, &c., electric fans, turbo-pump, electric ditto, projectors, arc lamps and resistances, are also noticed. Electric traction is dealt with popularly in outline.

The "Turret" Motor Bell.—In this bell, which is being introduced by the General Electric Company, Limited, the clapper, moving in a complete circle each time the gong is struck, a great impetus is obtained, with the result that a heavy blow is given, and consequently a much louder ring is produced, besides which, the time taken for the clapper to revolve gives the gong an opportunity of vibrating freely before it is again struck, so that a clear ring is produced. The motor used is stated to have no dead points, and is quite enclosed in a cast-iron box with self-oiling bearings. The bell is shown at work at the company's head office. The diameter of the gong is 10½ inches. A form of the "Turret" motor bell to work on 60, 100, or 110 volt circuits, is also made. This is intended for country houses as burglar, fire, or other alarm, and as it will work directly from the house mains, saves the cost of batteries.



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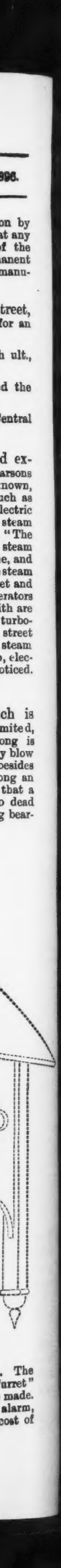
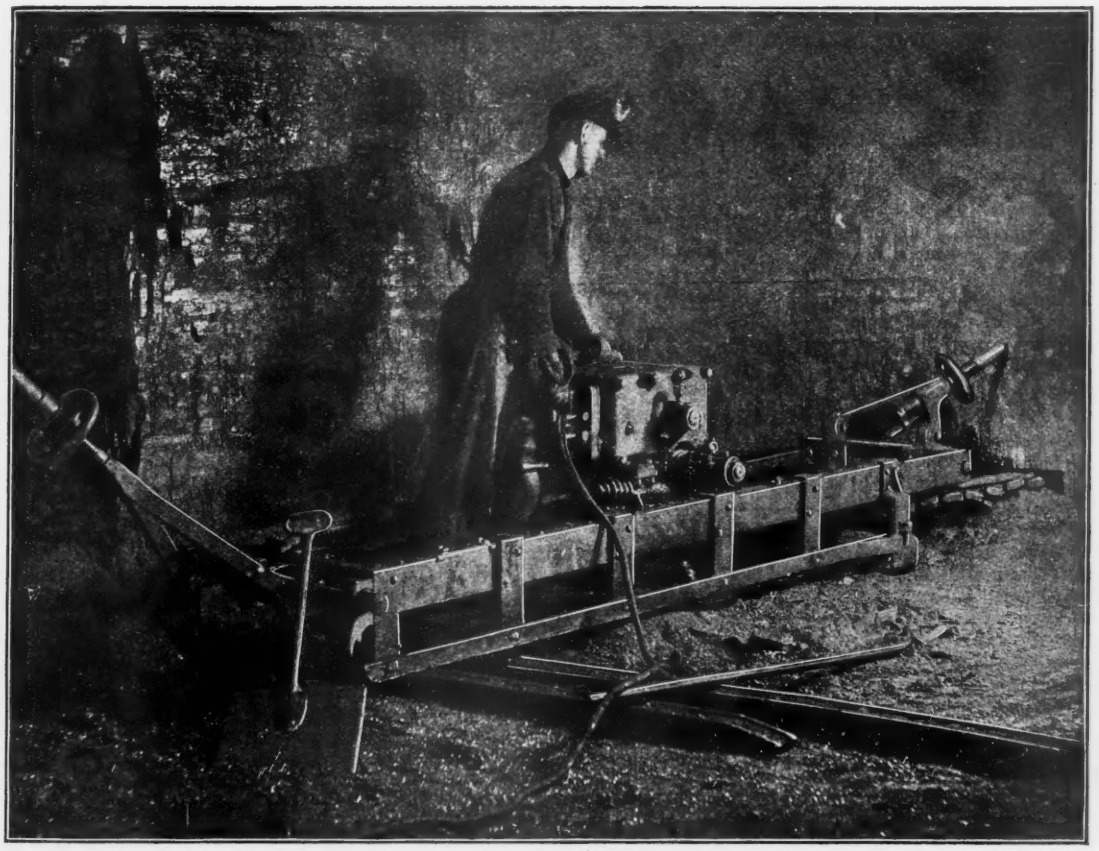


COAL-CUTTING BY ELECTRICITY.

The Jeffrey chain coal-mining machine, which is being introduced by Messrs. John Davis & Son, of Derby, can be operated either by electricity or compressed air. The machine is, we understand, used very extensively in the States, and is now being introduced into collieries on this side of the Atlantic.

The motor carriage, to which is fixed the motor and gearing, is attached to a sliding chain cutter frame, which slides along the stationary bed frame and carries the revolving chain, in which are fixed the knives, which, in size and shape, are all alike. The manner of using the apparatus is as follows:—The machine, mounted on its truck, is hauled to the face of the coal, the truck running on the rails or temporary track used for the mine tubs, the rear end of the truck is lifted, and the machine slides off, reaching at once its proper position to commence cutting. Connection having been made with the electric cable or air pipes, and the frame firmly jacked, the machine is ready to start. The operator generally remains at the rear end of the machine, his work being practically at an end until the machine has finished its cut. He then reverses the gearing by means of a lever, and the cutter frame travels back until it reaches a point where it is automatically thrown out of gear. The machine is then ready to be moved for its next cut, which can be readily done by two men, by means of crowbars, the front end sliding on its own shoe boards, the rear end on the skid boards provided for the purpose, as shown in the illustration. In addition to the operator, one other man only is required, to set the front jack, help shift the machine and shovel out the slack. The illustration shows the machine when its cut is about half completed. After the length of a face has been holed, the machine is again placed on its truck (this is easily accomplished by the two men in charge by means of the winch on the truck). A horse then takes it to the next stall or face to be holed. The average time occupied from the commencement of one cut to the beginning of the next is from five to eight minutes, varying with the hardness of the coal, the depth of cut being up to 7 feet × 3 feet to 3 feet 6 inches wide, about $3\frac{3}{4}$ inches in height being removed. The machine will cut equally well in fire-clay or clench, the horse-power absorbed varying from 8 to 15, according to the hardness of the material.

The average horse-power absorbed by the chain machine, as taken from a large number of readings in coal of varying hardness, works out at about 12. The Jeffrey machines are specially suitable for the pillar-and-stall system of working, but they are also extensively employed for heading, and in many pits they are doing good service in longwall work where the floor and roof are good.



Jeffrey Chain Coal Mining Machine, Showing Cut half Completed.

In connection with the machine a rotary drill of the same firm's manufacture is used to drill the holes for blasting down the coal. This puts in a hole 2 inches diameter 6 feet deep, in from two to four minutes.

SOLID CAST STEEL SPECIAL WORK.

The Steinway Railway Company, of Long Island City, has recently received from the shops of the Pennsylvania Steel Company an interesting piece of special work that contains several peculiar features. All of the frogs as well as the switches and mates are of solid cast steel made by the open hearth process. That this material is well adapted to such complicated construction will be revealed on a close examination of the accompanying engraving, taken from a photograph of the work as assembled on the inspection pavement at the factory. Particular attention is called to the nest of

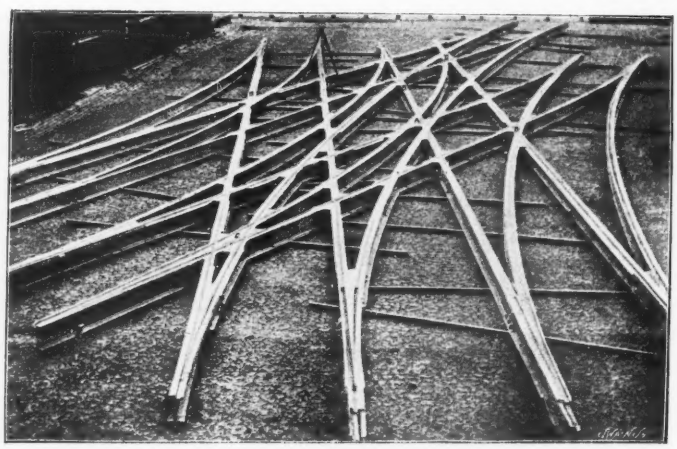
frogs at the point marked A. There are five intersections within a space of 3 feet square, which with the eight arms radiating therefrom, are comprised in one solid steel casting about 11 feet long and 5 feet wide. This piece if built up of rails in the ordinary way would contain not less than twenty separate pieces in addition to the fifty or sixty bolts or the mass of cast iron that would be required to hold them together. At the several points marked B there are three intersections or frogs contained in one solid piece. At C there are four. In other cases there are two frogs so near each other that the joint that would be used in ordinary work would be too short to be of much service—in such cases the joint is entirely eliminated and the two frogs connected in one casting. The few joints required in this class of work is an important feature. Another interesting fact, says the *Street Railway Journal*, in connection with this work is that but 38 per cent. of the track is made up of rail—the remaining 62 per cent. being steel castings.

TRANSMISSION OF POWER IN MINES.

By RANKIN KENNEDY.

V.

The chief difficulty in the way of the general adoption of the polyphase or induction motor into mining work, is the litigation difficulty. It has not yet been authoritatively settled whether any one patent controls this machine, nor to what extent it is controlled by the various patents in existence. The consequence is that no manufacturers care to expend time and money in promoting their application, for there can be not the slightest doubt that any successful application of induction motors of the polyphase type on a large scale would result in a contest over the patents.



Solid Cast Steel Special Work.

There are some good and valid patents concerning the various "improvements" on polyphase motors, but it is extremely doubtful whether any one, or more of them, can be held as a master patent controlling the whole of the polyphase motor business.

The first invention of the polyphase motor is due to one Baily, who made a model and exhibited it at work before the Physical Society more than 20 years ago. He produced his polyphase currents by commutating a continuous current.

The theory advanced by Baily was the correct one, namely, that the rotation was due to induced currents in the armature, or secondary part of the motor.

Tesla next came forward in 1887 with polyphase motors. He obtained his currents from alternators giving two or more currents in different phases. Alternators giving currents in two or three phases had been made long before this, and used for lighting purposes.

Tesla's theory explaining the rotations by revolving poles, or the so-called rotary polar theory, has long ago been exploded. It was totally unnecessary to get up a new theory to apply to induction motors, for as their conversion of energy was by means of magnetic fields and wires or conductors, just as in ordinary motors, the ordinary theory of electromotors was quite applicable, taking into account that the currents are alternating, and the fields of magnetic forces also alternating.

The iron in an induction or polyphase motor is used just as it is used in transformers and all dynamos—namely, to reduce the magnetic resistances and direct the magnetic flux. The only difference between a transformer and an induction motor is that in the transformer the whole magnetic circuit is fixed, while in the induction motor a part of the magnetic circuit carrying either the primary winding or the secondary winding is movable or free to rotate.

Instead of calling the one part the field magnet, and the other part the armature, we call the one part the primary and the other the secondary, everyone at once knows what these terms mean, and however the two parts may be combined in any one machine it is always easy to distinguish them.

In the Dobrowolsky, Haselwander, Brown, and Tesla polyphase motors, we have for two-phase machines two primaries acting on one secondary, for three-phase machines three primaries acting on one secondary; and in Brown's single-phase induction motor we have one primary and one secondary circuit.

In this country, Mr. Atkinson patented an induction two-phase motor with two primaries and two secondaries, the pairs being alike.

Subsequently the author brought out and exhibited for the first time, in 1890, a two-phase motor, in which one primary acted on a secondary incapable of rotating itself, but only inducing a secondary current, which flowing into an armature winding, was actuated by the other primary, forming, in fact, a transformer combined with a motor. This machine has a much higher power factor than any other induction motor can have, and is comparatively easily started up.

The author prefers to run the primary and fix the secondary for several reasons, the most important of which is that it is easier to insert starting resistances in the secondary when not moving, and these starting resistances should always be put into the secondary circuit.

The slip rings for the two primary circuits present no difficulties, and no sparking can occur there when properly made.

Asynchronous polyphase motors tend to run up to synchronism, but can never reach absolute synchronism.

These papers will be concluded by a description of a single-phase and a two-phase motor, with their starting gear.

THE INSTITUTION OF JUNIOR ENGINEERS.

Scottish Summer Meeting.

No doubt decided by the circumstance of Mr. A. Denny being this year's president, the Clyde district was selected for the 1896 summer meeting of the Institution, and nothing could have exceeded the warmth of the reception which everywhere awaited the members. The proceedings were inaugurated on Saturday, August 15th, at Edinburgh, where, in the City Chambers, at 11 a.m., the corporation presented an address of welcome, which was suitably acknowledged by the chairman of the Institution, Mr. H. J. Young. Other officers present at the meeting were the president, Mr. A. Denny; the vice-chairman, Mr. H. B. Vorley; Mr. W. B. Clarke, and Mr. A. Anstruther Thomson, members of council; and the secretary, Mr. Walter T. Dunn.

The engineering works visited at Edinburgh were the electric light station, the gas works, and the waterworks, all owned and operated by the corporation. The chief interest seemed to centre in the electric lighting arrangements, which are in charge of the resident electrical engineer, Mr. Frank A. Newington. Although opened on April 11th last year, the results have already proved here, as elsewhere, that, properly managed, the possible profits from such undertakings may form a considerable item of assistance to the ever-suffering ratepayer. The authorities are to be congratulated on the fact of the year's working returning an amount which it is understood will place the Edinburgh station at the top of the list in point of economical working. The price per unit has been reduced to 5d. for lighting, and to 3d. for power purposes; meter rents have been abolished, and there is a substantial reduction to large consumers of the current. One could not help remarking the inferior appearance of the gas lighting, by which the extensive adoption of the newer illuminant will, we think, be largely influenced. Prince's Street appears to be extravagantly lit, the arc lamps being placed only 45 yards apart. They are here on one side of the street only, it is true, and this splendid thoroughfare justifies a fully adequate illumination.

The electric lighting of the city was finally decided on late in 1893, when the work of designing and superintending the whole scheme of public and private lighting supply was entrusted to Prof. A. B. W. Kennedy. Having regard to the different districts to be served, and taking into account all the local circumstances, it was decided to adopt a low tension three-wire system for the central and northern districts, and an alternating current high tension system for the southern and eastern districts, both systems being worked from one central station and under the same control and management. A good site was found for the central station, between the Caledonian Railway and Dewar Place, where the foundation is rock. Whilst being fairly central, the station is in a neighbourhood where there is little chance of complaint as to nuisance, real or otherwise. The boiler house is 158 feet long × 48 feet wide, large enough to contain 17 boilers 12 feet long and 10 feet 3 inches mean diameter. At present 11 are laid down. They are of the dry-backed marine type, each fitted with two Purves flues 3¼ feet inside diameter, and 166 tubes of 3 inches internal diameter, working pressure 160 lbs. Superheaters, which have proved of immense value, are fitted at the top, each consisting of two nests of tubes enclosed between the top of the boiler shell and a fire-brick casing above, with a space left in the centre for the steam valves, safety valve, &c. Each superheater consists of 32 vertical flat coils of wrought-iron tube 1½ inch diameter, running from a large cast-iron pipe at the back of the boiler to a similar pipe at the front, all joints being outside and protected from the action of the gases. The two engine rooms, side by side, are each about 102 feet long. The one next the boiler house is used for the low tension plant, and is 46½ feet wide; the other, for high tension, is 41½ feet wide. The low tension machinery consists of 12 engines, four of 100 I.H.P., two of 250 I.H.P., and six of 360 I.H.P., with their dynamos; four of the latter are recent additions, and there is room for four more of the same size. All are Willans engines driving direct on to the dynamos, which are two-pole shunt-wound machines, with drum armatures, all wound to give 270 volts, except two, which are driven by two 100 I.H.P. engines, and wound to give 135 volts, used as balancing machines on the three-

Wood Working Shop, G. E. Co.'s Works.

Electrical Factories and their Machinery.—Main Erecting Shop, G. E. Co.'s Works.

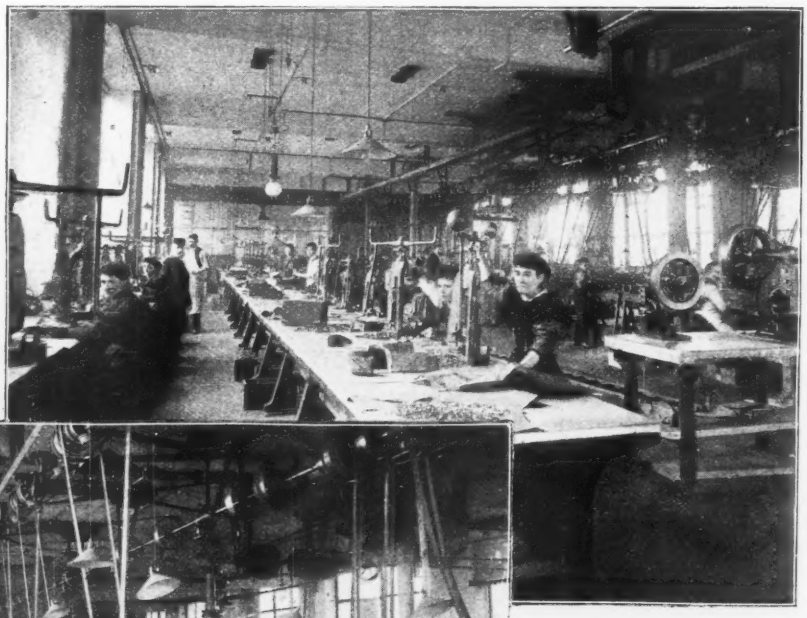
wire system. The whole of the machinery stands on a concrete foundation block, 7½ feet thick, separate from the foundations of the walls. The switchboard, and the whole of the apparatus for regulating the dynamos and batteries, and for the distribution of the current, are placed on a platform raised 4 feet above the engine room floor level, and running the whole way across the west end of both engine rooms. The switchboard consists of seven slate panels, each about 7 feet high, and stands 4 feet from the west wall of the engine room, allowing ample room to do any work on the connections at the back. The battery room is situated directly above this end of the low tension room. There are 132 cells of the new Crompton-Howell 31-plate type, divided into two half batteries, positive and negative. All the cells are similar, and have each a normal capacity of 1,000 ampere-hours, the normal rate of discharge being 200 amperes. Provision is made for a second battery of the same size. In the high tension part of the station are three engines and alternators, with their switchboard, and the rectifiers for arc lighting, with their regulating arrangements and switchboard. Two of the alternators are driven direct by a Willans three-crank engine of 150 I.H.P. on the same bedplate. The alternators are of the Ferranti type with stationary armatures. The core of sheet-iron segments is solidly bolted into the framing of the machine, with the coils threaded through holes in the sheet-iron, well insulated, and completely enclosed in brass boxes. The field magnets revolve, and consist of two heavy cast-steel discs, having on their circumference claws projecting sideways alternately over the field winding. The electromotive force is between 2,000 and 2,200 volts, with a frequency of 52½ complete alternations per second. The rectifiers, six in number, are of the Ferranti type. The feeders from the station are connected to the distributing mains at 24 points, and consist of two conductors only, the positive and negative; the middle wire is inter-connected throughout as much as possible, and is brought back from three districts on the system. The cables are put in parallel at the station, and one connection only is made to the switchboard. The positive and negative sides respectively of all the feeders are put in parallel at the switchboard; but any feeder or feeders can be put on a separate machine if required. With regard to balancing, its amount is compensated for at the station by means of the balancing machines, one of which can be put on either side of the system; during light load it is done from the battery alone.

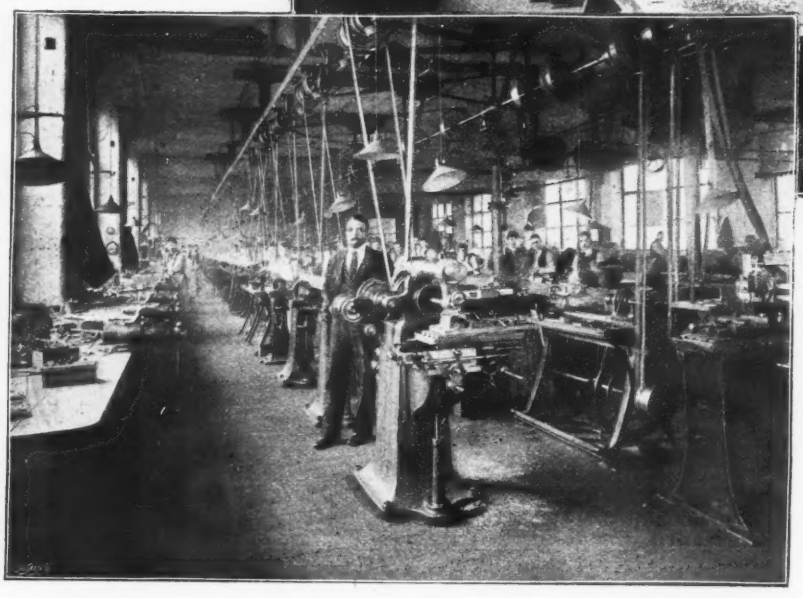
The distributing mains are insulated India-rubber cables, heavily braided, drawn into Doulton stoneware casing under the footways, and into either Crompton-Davis cast-iron casing or cast-iron pipes under the roadways. Wherever sufficient space has been found under the footways, the feeders have been laid as bare copper strip, carried on stoneware insulators in concrete culverts. Across all roads, and where there has not been sufficient space for culvert, the feeders are laid in Siemens armoured cable, laid direct in the ground. All have been designed to have a total drop of 44 volts at full load. The potential leads, by which each feeding point is connected back to the station, consist each of three sets of wires, insulated with specially-prepared paper, laid up together, and covered with the same material, a lead tube being drawn over the whole. All the cable connections are made by cone connectors, sweated on to the cables, and fitting into gun-metal connecting blocks.

For lighting the streets, over 300 arc lamps of the Crompton-Pochin and Brockie-Pell types, have at present been installed. Those in Prince's Street are constructed for a normal current of 15 amperes, and all the other low tension lamps for 10 amperes. In some of the streets in which no low tension mains are laid, the lamps are run on special high tension series circuits from the rectifiers at the station. The circuits are laid as concentric cable, drawn into cast-iron pipes, the outer conductor of the cable being insulated. There are about 30 lamps on each circuit, each provided with an automatic cut-out, in case of its failing to act; and also with a switch in the pillar, by which it can be entirely disconnected from the circuit, if necessary, while the switch is so made as to complete the circuits for the other lamps.

The Edinburgh gasworks, visited by the gas engineers of the party, were seen in some respects at a disadvantage, inasmuch as at the present time considerable alteration work is in progress. Mr. Masterton conducted the members over. The works cover an area of about 4½ acres, and the manu-

Stamping and Brass Finishing Shop, G. E. Co.'s Works.



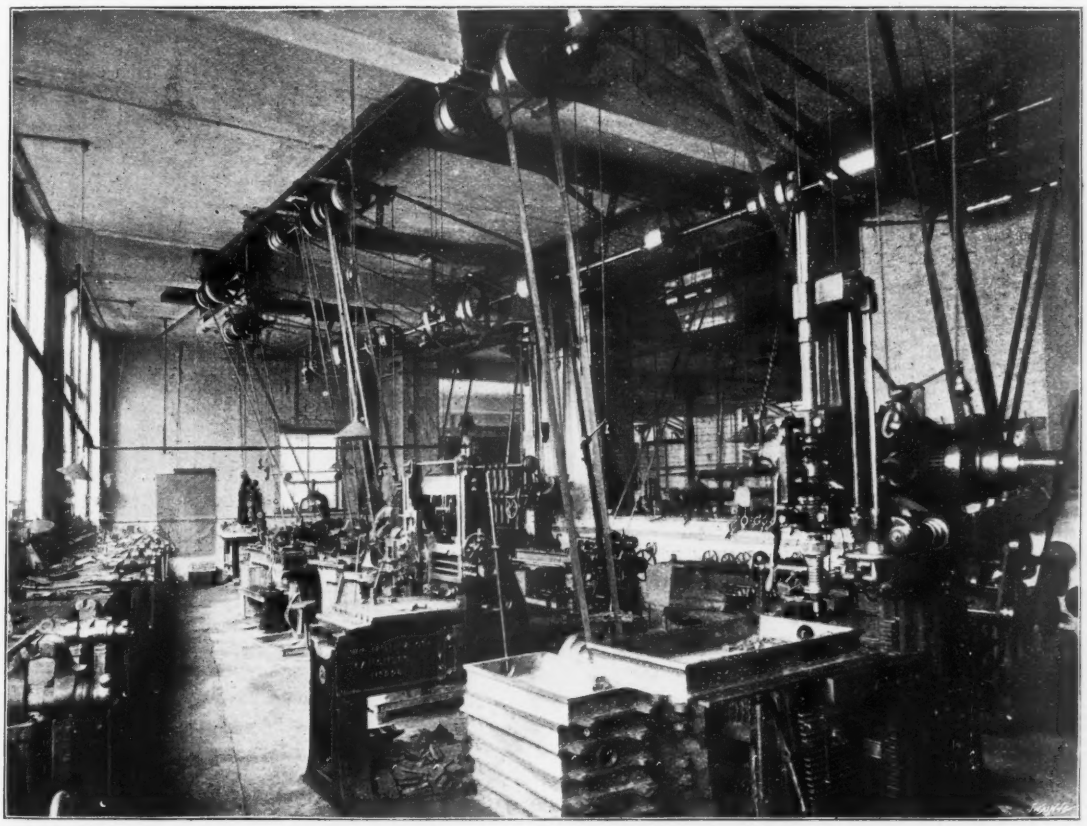


Electrical Factories and their Machinery.—Electric Light Department, G. E. Co.'s Works.

facture last year was 1,037,000 cubic feet of gas, distilled from 102,000 tons of coal, consisting of a mixture of splint, cannel, and shale. The heaviest day's make was 5,600,000 cubic feet. The illuminating power was 25·71 candles, and price is 3s. per 1,000 cubic feet. Messrs. Humphreys & Glasgow's carburetted water gas plant is being installed, which will be capable of producing 2,000,000 cubic feet per 24 hours; the remainder will be manufactured from coal in the ordinary coal gas retorts, fired in Siemens regenerative benches, charged and drawn by Foulis-Arrol stoking machinery.

In visiting the Edinburgh waterworks, at Alnwick Hill, the members had the advantage of the company of Mr. Oliver, of the Water Trust, who, in conjunction with the manager, explained the nature of the new work being executed to meet the increasing requirements of the city.

The total capacity of the works is some 15,000,000 gallons per day, and the consumption, for all purposes, 37 gallons per head per day. The population supplied is about



Electrical Factories and their Machinery.—Engineers' Tool Shop, G. E. Co.'s Works.

330,000, the rate being 6½d. per £ on the rental of dwelling houses, and 9d. per 1,000 gallons for trade purposes.

It was only to be expected that the programme of the meeting should include the opportunity for visiting the Forth Bridge, and on the Monday morning the party took train from Waverley to North Queensferry Station, a passage across the bridge over the metals being thus obtained. Met at the station by the resident engineer, Mr. A. Hunter, the party then walked across the structure, over a mile and a-half long, back to the south side; the numerous features of interest in connection with its design and erection being pointed out.

Commenced in December, 1882, the bridge was completed in March, 1890—7¼ years; 50,000 tons is its permanent load, and its total cost £2,225,000. The work is maintained in excellent condition, and, according to the opinion of an eminent authority, so kept, it will last 1,000 years. It being, of course, of the highest importance to protect the material—Siemens steel—from rust, a gang of about 40 painters are continually at work upon it; three years are occupied in painting the surface from end to end. On arriving at the south side the party took steamer, from which a fine view of the colossal erection was obtained. After luncheon at the historic "Hawes Inn," some of the members visited H.M.S. *Edinburgh* lying in the stream. The return to Edinburgh was made by brakes, the route being through some very interesting country. Leaving Auld Reekie at 6.50 p.m., the members of the Institution and Li Hung Chang were at 8 o'clock entering Glasgow together.

On the following day an excursion to the royal burgh of Dunbarton took place, Mr. A. Denny, the president, greeting the members on their arrival. Proceeding to the Municipal Buildings, they were there received by the Corporation. Provost Garvie, in the course of his address of welcome, said that while the Clyde generally might be far-famed for its shipbuilding, they had come to visit one of the great industrial centres on the lower reaches, widely known for the excellence of its workmanship and the perfection of its scientific appliances—he referred to the shipyard of Messrs. William Denny & Brothers. Mr. H. J. Young responded on behalf of the Institution. After again experiencing the hospitable nature of the Scottish race, on the invitation of the municipality a drive in brakes was enjoyed through Levengrove Park to the Rock, returning to Messrs. Denny's shipyard, where the firm entertained the party to luncheon, President Denny occupying the chair. Afterwards, dividing into two sections, the works were inspected, Messrs. A., P., and L. Denny acting as guides. Both in the shipyard and engineering shops there appeared to be plenty of work, the vessels in hand including a cargo boat 410 feet long, 8,300 tons dead weight, for the British India Steam Navigation Company; a paddle steamer 280 feet long, speed 19 knots; a twin screw vessel 280 feet long, for the London and North-Western Railway; a 350-foot passenger steamer for the Union Steamship Company of New Zealand, and a steel paddle boat, 310 feet × 46 feet × by 11 feet, for the Irrawaddy Flotilla Company's service at Rangoon. The steamers built are fitted with the electric light by the firm itself, a special department being established for this purpose. Undoubtedly the point of greatest interest was the experimental tank. The processes of constructing the paraffin wax models, and of testing them, was fully explained, and the general feeling was one of great admiration of the highly ingenious machines and devices by which the extremely accurate results are

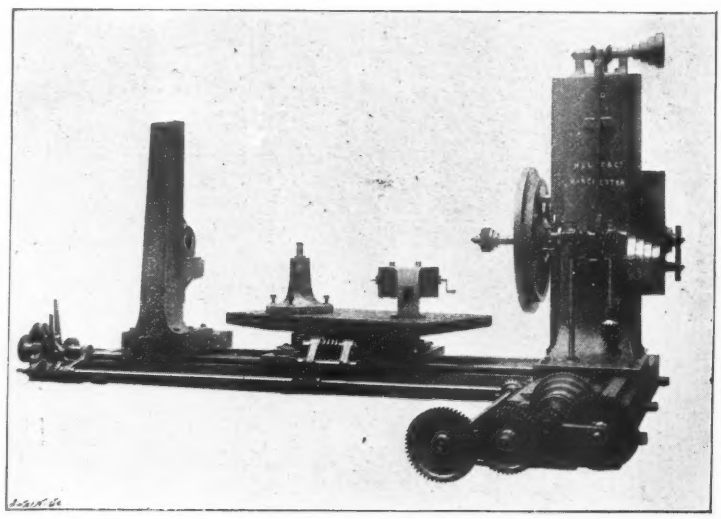
made possible. Messrs. Denny largely ascribe their success as builders of fast vessels to the information with which this experimental tank apparatus furnishes them. The efficiency of propellers, both paddle and screw, is also tested. The president accompanied the members back to the station, and ringing cheers were given him as the train steamed out on the return journey to Glasgow. Here, in the evening, and on Wednesday and Thursday evenings, the central electric lighting station was thrown open for visiting.

(*To be continued.*)

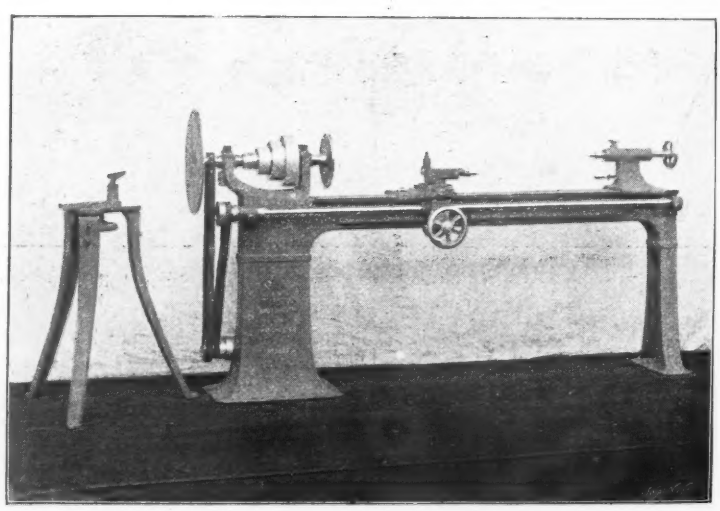
ELECTRICAL FACTORIES AND THEIR MACHINERY.

IV.

The General Electric Company's new works at Salford, Manchester, are provided with a large variety of machine tools, and it will be interesting to refer to some of them. In the arrangement of the works there is a good deal to be commended. The main structure, which covers an area of some 2,000 square yards, is divided into four principal floors, each of which is set apart for a distinct branch of manufacture. One portion of the ground floor is set apart for the general joinery and cabinet work, another for tool making, while considerable space is taken up by the main erecting shop. Three of the views in this article show these three shops. Outside the main building, and divided from it by an open yard, is an iron structure, 120 feet long × 40 feet wide, given up entirely to foundry purposes. Opposite the foundry is the engine house, which contains an uncommonly fine tandem engine made by Messrs. Hick, Hargreaves and Co. It is fitted with Corliss valves, and works up to 800 horse-power. As a reserve a smaller engine of 60 H.P., by Browett and Lindley, is employed. There are two boilers by Hick, Hargreaves & Co., which have a capacity of about 800 H.P., while there is abundant room for a third boiler, which, no doubt, will soon be necessary. Close by the boiler house is a smithy, which is provided with two hearths, though a third will, in all probability, be shortly added. In this smithy the chief of the iron work for arc lamps, brackets, &c., is done, the fires being kept up by a Roots blower. Leading from the smithy is a room in which are the power presses, which are used for stamping and other purposes; beyond this we arrive at the joinery or cabinet-making department, where the cases for telephones, switchboards, cases, frames, &c., are being rapidly turned out. It was interesting to notice how many operations are performed by machinery, polishing, finishing, and other work so often done by hand, is all carried out by machines. From each table the shavings and dust are collected by a blower, which is connected to the boiler house, so that the joinery shop is kept comparatively free from dust, and the shavings and dust which usually takes so much collecting drops on to the coal, and is burnt in the boiler furnaces. A very complete set of machine tools is in the joinery department, such as wood turning lathes, general joiners and planing machines. We are not going to attempt to give a complete account of these machines in this issue, but we will refer to a turning lathe with a self-acting feed motion which has been supplied by Messrs. George Richards & Co., Limited. The bed of the lathe, which is illustrated, is cast complete with the bearings carrying the spindle, while under the headstock is placed a heavy cored frame for the purpose of resisting the vibration in turning heavy pieces. It is fitted with a self-acting feed motion, together with compound rest, which is arranged to receive either tool-post for sliding, or standard tee-rests for hand turning. Tool rests are constructed to permit the tool rest and carriage to be fastened by one bolt, rendering it very convenient for sliding them back for measuring inside work. When turning large pieces, a face-plate is placed at the outer end, and the bracket which carries the thrust screw at the end of the spindle is removed.



Hulse & Co.'s Special Boring Machine at General Electric Company's Works.

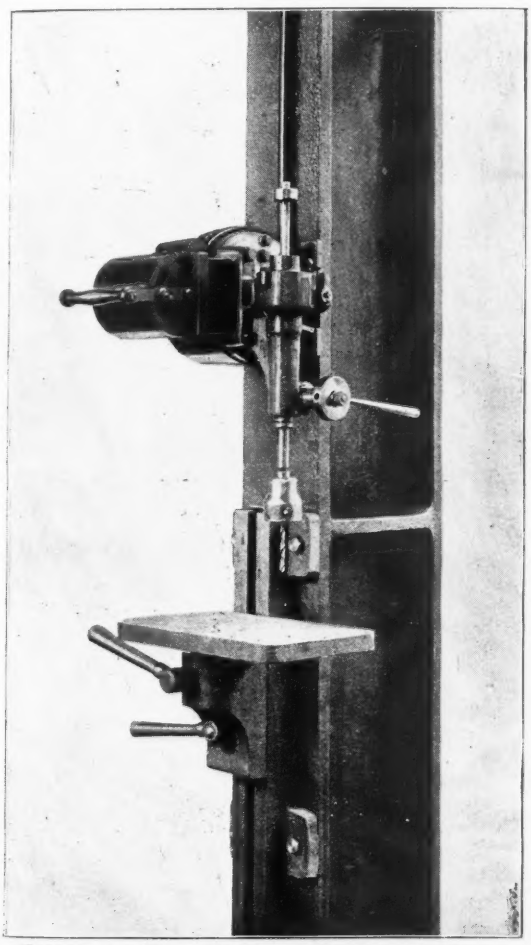


Richards & Co.'s Wood-Turning Lathe at G. E. Co.'s Works.

Messrs. Richards and Co. have also supplied other wood working machines, but these, as well as those supplied by Messrs. W. B. Haigh and Co. and Messrs. Thomas Robinson and Son, we shall leave for a subsequent issue. It might be explained that owing to the difficulties of photographing the joinery shop, the machines are not shown very clearly. Leading from this room is the engineers' tool shop, in which are some fine tools by Muir and others. Before leaving the ground floor we ought to refer to the main erecting shop, which is shown in one of our illustrations. Apart from the tools, one of the most interesting features here is the use of three-phase motors, both for driving shafts and machines direct. The overhead traveller, which at the time the photograph was taken was hoisting the heavy field magnets of a dynamo, is operated entirely by three-phase motors. The operation appears to be certain and facile, the slewing and

travelling being done rapidly and with exceedingly little noise. When the factory is in a completed state, three-phase motors will be extensively used, the motor which at present drives one of the shafting being of 9 horse-power. Other examples of three-phase driving, which are illustrated, are motor on a radial arm drilling machine, and a motor combined with a small drilling machine, fixed on one of the columns in the main erecting shop. In this department, which we have already said is reserved mainly for heavy work, is a three-phase Oerlikon generator, of 100 H.P. In the galleries surrounding this room armature winding for continuous current and alternating current machines is carried on.

It will be seen that there are numerous tools in this shop suitable for heavy work. At the moment we will only notice one, a special machine arranged for milling and drilling, and boring frames, and magnets for dynamos and similar work. The machine is one of Messrs. Hulse & Co.



Three-Phase Motor Combined with Small Drilling Machine at G. E. Co.'s Works.

The work is held on a rectangular table 7 feet × 3 feet 6 inches, which can be rotated by worm and wheel, and which also travels along a slide bed, either by hand or self-acting motion.

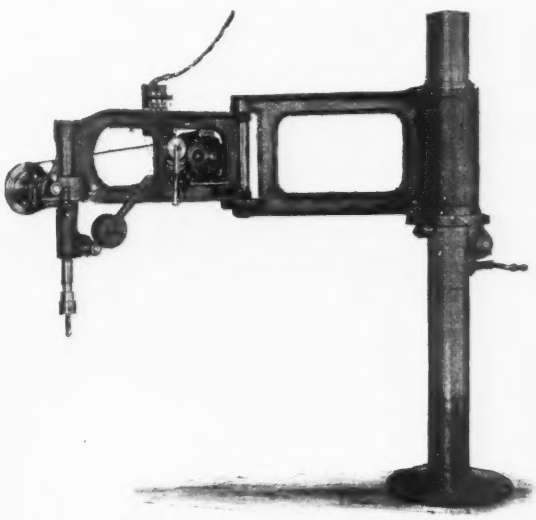
The drilling and milling tools are rotated by a powerful geared headstock, with a 3-inch spindle, having 24 inches of feed.

A face-plate 4 feet diameter, is provided to carry milling tools, &c., and a stay for the ends of boring bars adjustable in all directions.

There is a drilling apparatus shown lying on the table, by which, when fixed in place, two drills can be operated at once from the spindle nose.

Slow and quick power motions are provided horizontally and vertically to spindle, and horizontally to table, giving large scope of applicability to machine.

The first floor, or, as it is termed, No. 2 room, is devoted mainly to brass finishing and screw making; on this floor there are probably 150 lathes, milling and shaping machines, by Bradbury and other makers. In this room are ranges of steam pipes kept at an equable temperature for lacquering purposes, and close by is a series of hand-power presses used for stamping small work. The third room is devoted specially to telephone work, electrical cooking and heating apparatus, while the fourth room is given up almost entirely to the making of electric light fittings, switches, &c. There are, of course, many operations which it is impossible to note in this article, but before concluding, we will mention that the General Electric Company still own large premises at Chapel Street, which are mainly devoted to stores and show rooms. There is, however, a considerable amount of



Three-Phase Motor on Radial Arm Drilling Machine at G. E. Co.'s Works.

work done here in the manufacture of measuring instruments. Although on the occasion of our visit the workmen were somewhat inconveniently crowded, some 3,000 instruments are turned out annually. In the lower part of the building there is a small foundry for the founding of brass work. It is the intention, we believe, to gradually transfer the whole of the manufacturing work carried on here to the new works at Adelphi, Manchester, and the show rooms will be removed to more commodious premises in the centre of Manchester.

THE DELANY SYSTEM OF MACHINE TELEGRAPHY.

The committee appointed by the Franklin Institute to investigate the merits of the "Delany System of Machine Telegraphy" has now published the result of its labours in the *Journal* for August, together with a detailed description of the apparatus. The system is an ingenious combination of devices which are already in use (or which have been tried and abandoned) in such systems as the Wheatstone and Bain; the principal feature being that all the currents transmitted are equal in length, with the object of avoiding the difficulties due to the irregularity in the static charge and discharge which always ensues when ordinary dots and dashes are signalled. The following extract from the report sets forth the finding of the committee and the considerations upon which it was based.

"The committee charged with this investigation saw the apparatus in operation at the Franklin Institute, and afterward at the Philadelphia Bourse. Prior to that, one member of the committee saw it in operation over a commercial line 218 miles long, under the most unfavourable atmospheric conditions, the rain falling in torrents the entire length of the line. The conditions at the Institute and the Bourse simulated those of a commercial line in resistance and static

capacity as nearly as that could be done by rheostats and condensers. In every instance the record received was clear and perfectly legible, the speed ranging from 940 words per minute over the commercial line to 2,000 words per minute over the artificial line.

"The investigating committee is of the opinion that the device of sending impulses of equal length into the line,

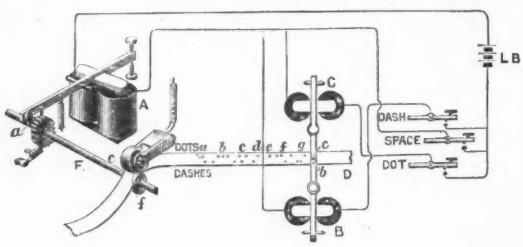


Fig. 1.

whether representing dots or dashes; the receiving of these impulses in different lines on the recording strip, by the use of a suitable stylus and by the reversal of the polarity of the current; the invention of a contact brush, which ensures a perfect contact at any desired speed, and the many small details in the apparatus not specifically mentioned in this report, which, combined, produce a certainty in the results not hitherto attained in the art of telegraphy, and secure a speed in transmission and reception many times greater than by any other method, all constitute an invention of the first class, and are worthy of the highest commendation.

"The Franklin Institute, therefore, awards the Elliott Cresson medal to Patrick B. Delany for his system of machine telegraphy."

We naturally compare such a system with the Wheatstone system as worked by the Postal Telegraph Department in England, by means of which a speed of over 600 words per minute can, if necessary, easily be obtained as an experiment. When, therefore, we read that Mr. Delany's system secures a speed *many times* greater than any other method, we expect "many times greater" to mean at least "twice as great," that is, 1,200 words per minute, and we are disappointed to learn that at the only real trial recorded the

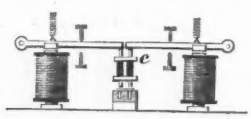


Fig. 2.

speed did not exceed 940 words per minute. The report states that this result was obtained "under the most unfavourable atmospheric conditions, the rain falling in torrents the entire length of the line"; but as a matter of fact, such a state of affairs is generally one of the most favourable for high speed working, as the heavy rain washes the insulators clean, and, while they are wet, a uniformly low insulation resistance is obtained which is of enormous assistance in allowing the electrostatic charge to escape to earth after every signal. It was discovered at least 20 years ago that it is extremely difficult to obtain a very high speed on a perfectly insulated line, as in such a case the line can only discharge itself at its ends; and it is the excessive and irregular discharge at the receiving end which is such an important factor in the distortion of signals. Mr. Delany's is essentially a single-current system, and there is, consequently no doubt that the conditions which the committee consider were "most unfavourable," were, in reality, favourable.

No trial on an artificial line affords any information as to the actual commercial value of any apparatus, and it is sufficient to mention that the speed of 2,000 words per minute has been exceeded by other systems on artificial lines.

In another section of the report the committee refer to the wire brushes which are employed for making contact through the perforations in the paper at the transmitting station, and they inform us that "in all other automatic systems this contact has been made by a wheel, or brush, with the drum, and has resulted in much uncertainty. They are apparently unacquainted with the most important of all automatic systems, viz., the Wheatstone, in which there is no contact-brush, roller, or drum, but in which the perforated paper is used simply to permit or prevent the vertical movement of two pins which do not themselves make electrical contact, but which govern the movements of a vibrating contact lever. Such a method gives far more reliable results than any contact made through perforations in a rapidly moving paper; and it has the further important advantage that the perforated paper is not injured thereby, but may be used over and over again on different circuits, a proceeding which is frequently necessary for press and similar work. In Mr. Delany's new system the signals are received upon chemically prepared paper, being produced electrolytically as in the chemical receiver invented by Bain just 50 years ago. This method has some advantages, but among others it has the serious practical disadvantages that the paper must be kept moist and requires careful handling, and signals are not perfectly distinct unless the paper is moistened to exactly the right degree.

Although we might have thought more highly of the Committee of the Franklin Institute as experts in high speed telegraphy, had they awarded the Elliott Cresson

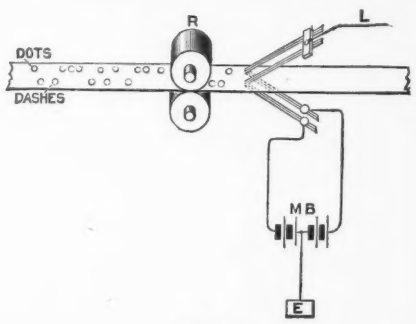


Fig. 3.

medal to Mr. Patrick B. Delany without stating their reasons for so doing, yet we are bound to admit that the system embraces one or two interesting points, and we will therefore briefly describe it.

The "perforator" which is employed to prepare the ribbon or paper slip for the transmitter at the sending end of the line comprises three keys and three electro-magnets, as shown in fig. 1. The spacing electro-magnet seen to the left in the figure is brought into circuit and actuated when any one of the keys is depressed; its armature is attracted and the free end of the lever being thereby raised the pawl carried by the lever is enabled to engage in a fresh tooth in the ratchet wheel at *a*. When the key is allowed to rise, the armature also rises and the spiral spring attached to the lever forces the ratchet wheel one tooth forward, and the paper is pulled forward a definite distance

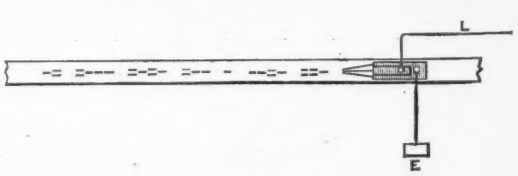


Fig. 4.

by means of the toothed wheel, *f*, and the pressure wheel, *e*. When the middle or spacing key is depressed, the paper is simply pulled forward one space; when the left or dot key is depressed, a hole is also punched through the paper near the upper edge; and a similar hole is punched near the lower edge when the right hand or dash key is actuated. The appearance of the perforated paper will be clearly understood from fig. 1, and the perforating electro-magnets are illustrated in fig. 2, from which it will be seen that a small punch is fixed on the extreme end of each of the levers.

The principle of the transmitter is shown in fig. 3. The perforated paper is drawn between two pairs of brushes by

means of the rollers, R, which are driven by a small electric motor. Each brush consists of six wires, the upper pair being connected together and to "line," while the two brushes forming the lower pair are insulated from each other and connected respectively to the positive and negative terminals of the two main batteries. A positive or a negative current will therefore be sent to line according as the brushes make contact through the dot holes or the dash holes. The principle of the receiver is shown in fig. 4.

The paper, which has been moistened in the chemical solution, is drawn forward at the requisite rate under three iron wires which lightly press upon it. The two outside wires are connected together and to "earth," while the middle wire, which is insulated from the other two, is joined to "line." It will thus be seen that according to the direction of the current a line will be traced either under the middle iron wire or under each of the outside iron wires, and the apparatus is so connected up that a short signal traced by the middle iron wire represents a dot, while two short signals traced simultaneously by the outer iron wires represent a dash. A specimen of the signals obtained by this method is given in fig. 4, and it will be observed that while these signals can be easily read by anyone acquainted with the ordinary method, they are somewhat less liable to the confusion due to the mis-reading of dots for dashes, or *vice versâ*, because the difference is determined by the position and not by the length of the signals. This is, in fact, a most important advantage, and the device by means of which it is obtained is decidedly ingenious.

The inventor of the system lays considerable stress upon the fact that all the signals are obtained by currents of the same duration, and that, consequently not only is less time required to send a given number of signals, but the signals can be transmitted at a much greater rate because the charging and discharging of the line is more regular, and the amount of the charge is not so great when sending dots as when sending ordinary dashes. There is a great deal to be said in favour of these claims, but as we have previously pointed out the system is practically a single current one, and the receiving apparatus is therefore open to the reception of stray currents between every signal; and as the Bain apparatus is essentially sensitive, it means that it would not be possible to work the line however slightly it may be in contact with another working line. Much better results would be obtained by using the Wheatstone automatic system with the transmitter modified so as to send currents of uniform length. This method was tried and abandoned many years ago as the ordinary method gives far better results. Further it must not be supposed that any such system could insure a uniform charging of the line, because this would only happen if the matter to be transmitted were arranged so that positive and negative currents followed alternately—a manifest impossibility.

BUSINESS NOTICES.

(*Continued from page* 494.)

"M.D." Arc Lamps.—These are not lamps which have obtained a degree in medicine, but are the electric arc lamps which are being manufactured under the Moody-Davis patents by Messrs. Moody Bros., of 68, Victoria Street, Westminster, S.W. The makers recognise that English made goods are more than ever in favour in this country, and consequently they draw attention to the fact that these M.D. lamps are entirely English both in design and manufacture. They also claim that the lamps are by far the simplest in the market, having only one moving part in addition to the carbon holders and the spindle that carries them. Messrs. Moody have just issued a large wall sheet devoted to their manufactures in this direction, and in referring to this M.D. lamp, they call special attention to the form, the guide rods, and carbon holder carriers, which they consider a successful device to ensure that perfect freedom of movement of the carbon holders at varying temperatures, which is so essential to the proper working of an arc lamp. The list before us also contains some very artistic patterns of arc lamp brackets, standards, and fittings. A good deal of general information regarding arranging lights, current and C.P., carbons, &c., are given, also prices.

Partnership Notice.—Mr. Guy C. Fricker informs us that he has taken Mr. Francis Miller into partnership, and the name of the firm will in future be Fricker, Miller & Co. The offices of the firm will still be situated at 149, Fleet Street, E.C.

Telegraphic Addresses.—Mr. Henry Sell has published his No. 3 Supplement of Registered Telegraphic Addresses.

ELECTRIC LIGHTING NOTES.

Aston.—At the District Council meeting last week there was a slight variation from the ordinary rule. For the space of 15 minutes business had to be carried on by the aid of light from wax matches only, the electric light having failed.

Ayr.—Mr. Pink, the resident electrical engineer, reports that the total expenditure to August 31st last was £22,112 13s 9d., and that the accounts in hand to September 30th amounted to £1,500. The Council has adopted the Lighting Committee's recommendation to procure a high speed plant of 200 kw., including cables, &c., at an estimated cost of £5,000.

Bangor.—A proposal to acquire land for the extension of the gasworks came before the City Council on 7th inst., and was defeated by 11 votes to 9.

Balby and Hexthorpe.—A committee of the District Council has been appointed to consider the lighting of the township. Electric lighting will be borne in mind.

Belfast.—The Electric Committee, in drawing up the 1897 estimates, has made provision for carrying out a considerable portion of the electric lighting extensions.

Birmingham.—If Mr. Albert J. Cook, who is seeking election on to the Council, has his way, the electric light undertaking at Birmingham will follow in the footsteps of Liverpool, and will be purchased from the Electric Supply Company by the Town Council. He considers the system should be directly under Corporation control. He said a few days ago the shares stood at such a substantial premium, that it occurred to him that the city had lost a good source of income, and although he believed he was right in saying that the lease acquired by the company was for 42 years, still he should welcome any fair and equitable agreement that might be arrived at whereby the Corporation should acquire the installation. Alderman Pollack also considers that it is not too late to take such a step.

Bolton.—The Council has approved of recommendations to borrow £30,000 for electricity purposes.

Bootle.—The Watch Committee has advised the Corporation to utilise its electric lighting powers at once by giving instructions for securing a site, and taking the other steps necessary for laying down an installation. Mr. T. L. Miller has submitted a report, and proposes a scheme costing £21,000.

Bristol.—The contract for the new works at the Central Lighting Station has been signed. The appointment of a clerk of works has been referred to the Works Sub-Committee.

Buenos Aires.—A River Plate journal contains the following items of information regarding the electric lighting of Buenos Aires:—Sr. Juan Abella, chief of the Public Lighting Department of the Buenos Aires municipality, has returned from his visit to Europe and United States, where he was sent by the Municipality to study questions of public lighting.—The Mayor of the city of Buenos Aires has ordered the Public Lighting Department to draw up a scheme for lighting the more central part of the city by electricity.—"The Public Lighting Department of the Buenos Aires Municipality has presented a set of rules and regulations governing electric light mains and installations. These have been adopted from the regulations in force in Europe and the States, and from what we have been able to gather, may be the means of improving house installations."

Bury.—The committee has arranged to have a sliding scale of charges, and the maximum charge of 8d. per unit, instead of 6d., will be inserted in the provisional order.

Burton.—In the early days of last week several failures occurred in the electric lighting. They are stated to be due to defects in the distributing cables.

Cheltenham.—Cambray Chapel has been lighted by electricity, Mr. A. G. Sanders being responsible for the electric wiring. Four 100-C.P. lamps are suspended from the ceiling, 12 32-C.P. lamps light the galleries, and a similar number of 32's light beneath the galleries. The total C P. of the lamps fitted is 3,144.

Colchester.—The Ratepayers' Association has expressed disapproval of the Council's electric lighting scheme.

Combe Down (Bath).—Negotiations are pending with Mr. Freeman for supplying the necessary power for lighting the district by electricity for the Parish Council, water-power being used. It is also stated that, failing the success of these negotiations, several gentlemen are prepared to form a syndicate. The gas company has refused to reduce its charges.

Cork.—The Corporation on 6th inst. had a long discussion regarding the electric lighting of the city. It was decided to accept the tender of the Cork Electric Tramways Company for transference to them of the Electric Lighting Provisional Order, 1896, subject to the modifications and additions to said tender embodied in letters from the company's solicitor, and approved by the committee.

The contract for electrically lighting the new Palace Theatre has been given to Messrs. Handley & Shanks.

Crewe.—The new Isolation Hospital is to be lighted electrically, refuse being burnt for raising steam.

Darwen.—A sub-committee, after considering the report of an expert upon the proposed electric lighting scheme, recommends the Corporation to go in for more light.

Dublin.—The offices of the *Irish Independent* are now lighted by electricity, the work having been done by the Liverpool Gas and Electric Lighting Company. A Taunton dynamo, driven by a 22 H.P. gas engine, supplies current for 200 lights.

Dundee.—The report regarding the proposed extension of the electric lighting, which was drawn up by Mr. W. Tittensor, the electrical engineer, was before the Gas Committee on 6th inst. It is proposed to extend the area from ⅜ mile to 3¾ miles. In the matter of street lighting, it is stated by Mr. Tittensor that to effect an improvement it would be necessary to do away with the present lanterns and adopt the canopy system. This change would cost £8 10s. per lamp, or £34 in all. As to the charge for the current, the present rate was 5d. per unit, this being the same as that charged to ordinary consumers. No charge was, however, made for carbon trimming or maintenance. Last year the four lamps burned altogether 3,709·5 hours, costing £154 11s. 3d., or at the rate of £38 12s. 9¾d. per lamp per annum, or 2½d. per lamp per hour. He had written to the 10 principal towns in Scotland with regard to the systems in operation, and had found that in Edinburgh the charge was £18 per lamp per annum. As, however, half the lamps were switched off at midnight, the actual cost was £24 for lamps burned all night, and £18 for those burning only part of the time. It had been recommended that they should supply current to the four High Street lamps, and do all the trimming and maintenance for £25 per lamp per annum. That was at the rate of 3½d. per unit, including everything, being a reduction of 35 per cent. on the usual rate to ordinary consumers. He thought they would be unable to supply current to the High Street at the low rate suggested. He considered that the standards should be each fitted with two bracketed arms carrying two 50-C.P. lamps, and that at 11.30 p.m. the arc lamps be turned off and those lamps be turned on, a system which would give sufficient light for any traffic which might be in the street in the early hours of the morning. On these lines High Street could be supplied at £25 per lamp per annum, this being about cost price, otherwise the street would be lighted at a loss. Reporting upon the extended scheme of lighting in the principal streets of the city, Mr. Tittensor said that 56 extra lamp-posts would be erected with bracket-hangers and lamps with the necessary mains and pipes. Of these, 32 would be burned all night, and alternate lamps, numbering 26 in all, would be turned off about midnight. He suggested that the energy be supplied at the rate of £20 per lamp per annum, including trimming, but exclusive of interest and sinking fund. Fifty-six lamp-posts with hangers and lamps erected complete at £30 each would cost £1,680, lighting and supply pipes for cables, £175; cables and switching gear, £330—a total of £2,185. To this had to be added interest and sinking fund, £110; running cost—the supply of current and trimming at £20 per lamp per annum—equal to 3d. per unit, and including trimming, £1,200. The Committee approved generally of the report, reserving the details for further consideration.

Eton.—The District Council has approved of the draft transference of the electric lighting order from the Windsor Corporation to the Windsor and Eton Electrical Installation Company.

Electric Lighting of the Embankment.—At Tuesday's meeting of the London County Council, Col. Ford had a motion on the agenda regarding the lighting of the Victoria Embankment and the Waterloo and Westminster Bridges by electricity. The resolution was, however, withdrawn, as the Highways Committee is about to deal with the subject.

Hampstead.—The agent of the Norwich Union Fire Assurance Society has informed the Vestry that, in accordance with instructions from the Fire Offices Committee, the rates on £13,000 for the building and contents, exclusive of dynamos, will be increased from 5s. to 10s. 6d. per cent.

Hartlepool.—The Corporations of the Hartlepools are at present considering a proposal made by the Hartlepool Electric Tramways Company to light both towns electrically. One of the towns already has its provisional order, and the other is applying for powers.

Hove.—The Council has agreed to a modification of the agreement with the Electric Lighting Company so as to permit them to supply electric energy at a pressure not exceeding 220 volts at the consumers' terminals in new streets in which electric lines are hereafter laid, and to new consumers in streets in which electric lines are already laid.

Llandrindod Wells.—The seal has been affixed to the agreement with the Electric Light Company for lighting the streets by means of electricity.

London.—It is probable that very shortly the Works Committee of the London School Board will require tenders for an electric light installation, and the necessary wiring and fittings for the new store on the Bowling Green Lane site, Clerkenwell.

Mile End.—A committee's recommendation that the Vestry oppose the application of the County of London and Brush Provincial Electric Lighting Company for a provisional order to light the hamlet by electricity, has been referred back, the company asking that they might be allowed to lay before the Vestry a scheme which would be advantageous to the hamlet.

Newmarket.—A special meeting of the Council was held on 7th inst. to consider a motion applying for a provisional order. It was impossible to do anything at the meeting, for a certain member caused so much uproar by interrupting the vice-chairman, accusing him of having "told lies," refusing to withdraw that expression, continuing speaking in defiance of the chair, &c., that the proceedings were suspended and the meeting adjourned until 21st inst., by which time it is to be hoped the gentleman in question will have calmed down somewhat. He had moved an amendment adjourning the electric lighting matter for four weeks, in order that a public meeting might be held. Of course, he was perfectly in order in making such a proposal, but his wiser course would have been to say less, and that in just a little calmer manner.

Partick.—The Police Commissioners have given consent to extensions of cables to be laid down by the Kelvinside Electricity Company.

Rathmines.—Before the Commissioners set to work upon the £40,000 electric lighting scheme of Mr. Hammond, they have decided to obtain the opinion of a second expert regarding it. Prof. Kennedy's name is suggested.

Shoreditch.—The resident electrical engineer, Mr. R. F. Ferguson, has resigned his position, and applications are now invited for the office. The Vestry is to make application to the L.C.C. for consent to borrowing £24,800 for 42 years in respect of No. 4 contract (engines, pumps, transformers, &c.).

Stafford.—The Council is reducing the charge per unit as from the commencement of the present quarter. Alderman Peach stated at the last meeting that the result of the working of the electric lighting department for the year ending March 30th showed a profit of £105, apart from the question of interest and sinking fund.

Stirling.—The advice of an expert (Prof. Kennedy is suggested) is to be taken regarding the advisability of the Council putting down an electric lighting installation for the town.

Stretford.—A sub-committee is dealing with the matter of electric lighting, and Mr. J. Bennett, electrical engineer, has been retained to prepare a short detailed scheme.

Taunton.—A Local Government Board inquiry was held on 9th inst. regarding the Council's application to borrow various sums, including £3,000 for electric lighting purposes.

Torquay.—The Town Council last week approved of the plans, general conditions, and specification of the works connected with the erection of municipal electricity supply works. Advertisements are to be issued inviting tenders for the supply and erection of the plant in accordance therewith. In the course of the discussion it was stated that the chairman of an Electric Lighting Committee in a Midland town strongly advised that Torquay should not go in for arc lamps, as proposed, for street lighting.

Wakefield.—It is stated that the electric lighting arrangements are progressing satisfactorily. It is expected that the supply will be ready by August 1st, 1897.

Wigan.—At the last Town Council meeting, Alderman Holmes stated that the Electric Lighting Committee had decided to abandon for the present the scheme for electric lighting in the borough "owing to the depression in trade."

Winchester.—The Council has decided to transfer its electric lighting provisional order to Messrs. Edmondsons, Limited, upon the following terms:—The cost of the order, some £350, to be repaid to the Council by the company, provision to be made for the purchase of the works by the Council on giving a year's notice. If within seven years of the transfer, the price to be the capital expended, plus 15 per cent.; if after seven years, and within 14 years, the capital expended, plus 10 per cent.; if at any time after 14 years, the capital expended, plus 5 per cent. The charges to the consumers to be 8d. per unit for the first year, 7d. for the second, with a sliding scale down to 6d. to large consumers. The public lighting to be charged 4d. per unit; the Corporation to decide the site of the works, the compulsory area, &c. The Mayor stated that the expense of the works, site, &c., would be about £15,000.

Withington.—The District Council is to oppose any applications made to supply electricity within this district, and to apply for a provisional order for itself. A committee has been appointed to take the necessary steps.

When the town was canvassed for the purpose of ascertaining the probable number of consumers of the electric current, more than 600 persons favoured the proposal, over 400 promising to become consumers; 179 opposed the proposal.

Yarmouth.—During September two more customers had been obtained for 227 lamps, making 188 customers for 9,279 lamps. The income for the month was £314 3s. 4d., showing a balance of £141 12s. 5d. to meet capital and sundry charges of £130 per month. It was resolved to reduce the Corporation's charge to 4d. per unit for current supplied for motors and for warming purposes.

York.—The opposition to the electric lighting scheme still continues, and the opinion of each candidate for the municipal election is to be taken.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Altrincham.—The District Council has approved of the minutes of a special meeting regarding the electric tramway. The Council is, however, strongly opposed to the use of the overhead trolley system or the use of steam power. The Council reserves to itself the right to purchase any portion of the system which runs through Altrincham.

Bolton.—The Town Clerk was last week instructed by the Council to give notice of a Bill to be promoted in Parliament by the Corporation, enabling them to work and extend the tramways, electricity being used thereon. Various other powers are also sought under the Bill.

Dublin.—It is understood to be the intention of the Dublin United Tramways Company to promote an Order in Council to authorise their making extensions in the city and townships, including the line originally proposed by them from Rathmines to the sea *vid* Ballsbridge.

Dundalk.—Mr. F. J. Warden Stevens has advised the Commissioners, while combining an electric traction scheme with an electric lighting ditto, to keep the latter in their own hands, and to make an agreement with the tramway syndicate to supply them with electric current at certain rates. The suggestion was considered favourably by the Commissioners and the matter referred to Committee. We understand that the proposals as to the tramways have not yet been laid before the board.

Isle of Man.—The Ramsey Town Commissioners have decided to invite two companies who are competing for powers to construct an electric railway from Laxey to Ramsey to lay their respective schemes before the board, so that the Commissioners may judge which to support when the matter comes before the Tynwald Court on the 28th inst.

Lanark.—The Lanark County Council has appointed a Committee to examine into the advisability of applying to Parliament for powers to construct throughout the county, tramways driven by electricity or other motive power, and to report.

Middlesbrough.—The Streets Committee has received an application from the Tramways Company for certain alterations and extensions of the tramway system, in order that the whole may be worked by electricity. The Committee asked for further particulars of the proposals, with a plan. It is proposed to visit Bristol, and inspect the electric tramways there.

TELEGRAPH AND TELEPHONE NOTES.

Cause and Effect.—The equilibrium of the editor of a Brazilian newspaper seems to be quite upset by the laying of the Amazon cable, for upon the occasion of the inauguration of this cable he was, we understand, safely delivered of the following mighty paragraph, which even excels the comments of the editor of a certain London contemporary in dreaminess and verbosity:—"Upon the realisation of this legitimately patriotic event, the Amazon, as if wounded by the shock of great commotions, felt the red blood freezing in its arteries. Now its heart is palpitating ardently, and its broad, bronzed breast is absorbing with the air the light which is poured down in a golden profusion of auroras and sunbeams. And while the Giant, the haughty Lion of the North, slumbered on his couch in divine ecstacy, the universal god, the wise god Progress, poured into his breast a vein of light like unto a running rivulet, limpid and brilliant. And this mighty vein, filled with a liquid compounded of globules of sunrays, is called—Telegrapho!" How thrilling! But what has all this to do with matter-of-fact telegraphy?

Coast Communication.—The "Smalls," situated 20 miles from the mainland, at the entrance of St. George's Channel, and within signal distance of the Bristol Channel, having drawn the attention of the authorities as being most suitable from strategic and other points of view, has been connected by cable with the mainland. The telegraph steamship, *Monarch*, arrived in St. Bride's Bay, from whence, says the *Western Morning News*, the process of laying the cable commenced.

Some Features of the River Plate Telegraph Service.—The *Review of the River Plate* says that the Post Office Department there pays the telegraph linesmen the handsome salary of 50 paper dollars a month, or say about £3, and for this princely wage they are expected to keep a horse and have sufficient technical knowledge for the post they fill. "No wonder that the National lines are always in such deplorable condition." Our contemporary in another paragraph says: "The delay in the transmission of telegrams in this country is notorious, and letters frequently arrive before telegraphic messages, although posted after these have been sent. If anything, the National telegraph department is the greatest sinner, and from the delays which take place in this department, it would appear as if the messages get off the wires and walk the greater portion of the distance."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Penang-Medan	Sept. 17th, 1896 ...	Oct. 10th, 1896.
Para-Maranham	Oct. 8th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok	Oct. 8th, 1896 ...	Oct. 12th, 1896.
Bolinao-Manila	Oct. 10th, 1896 ...	Oct. 10th, 1896.

Telegraph Rates to the Far East.—In a communication to the Liverpool Chamber of Commerce, the Duke of Norfolk, Postmaster-General, regrets that his representations to the telegraph companies in favour of a reduction in the rates to India were fruitless in face of the great loss of revenue involved. The companies have, however, made appreciable reductions in the charges for telegrams to the Far East, particulars of which will be duly announced. China, for instance, will be reduced from 7s. to 5s. 6d. per word. Reductions will also be made in the charges to Spain, Portugal, Gibraltar, the Canaries, the Azores, and Tangier.

The New French Cables.—New York despatches dated October 10th, state that "Three steamers belonging to the French Cable Company are now at Halifax preparing to lay the cable between France and the French colonies in America."

The Telegraph Wire Export Trade.—During the past month or so there has been a steadily increasing activity in the export trade of this country in telegraph wire and apparatus connected therewith. The total for August last (£65,176) showed a fair increase against the preceding month, while the returns relating to September show a further advance, the exports during September having attained a total of £76,273, as compared with £45,268 in the corresponding month of last year. As the year progresses, the position of the trade as compared with 1895 becomes more satisfactory, but at present there is nothing like the activity as prevailed in 1894, as will be seen from the following figures:—

Exports—First nine months,	1896	£537,857
" " "	1895	383,437
" " "	1894	1,304,594

The United States and Cable Companies.—The *New York Journal* of the 2nd inst. contained the following:—United States District Attorney Wallace Macfarlane, by direction of Attorney-General Judson Harmon, filed yesterday in the office of John A. Shields, clerk of the United States Circuit Court, a bill of complaint in the suit brought by the United States against the following companies:—La Compagnie Française des Cables Telegraphiques, the United States and Hayti Telegraph and Cable Company, and the United States and Hayti Cable Company. An injunction is sought to restrain these companies from combining "to monopolise a part of the trade between the United States and other countries." The argument in brief is that the French Company has exclusive right to land in certain South American countries and in West Indian islands. The United States will not allow it to land here until American companies can land there. The two other companies are American companies, organised to lay a line from Coney Island out 10 miles, joining the French cable. This it is sought to prevent. La Compagnie Française des Cables Telegraphiques is the successor in interest of other French companies in the ownership of cables between the United States and France, and in and between several islands of the West Indies, and of other cables extending from these islands to several South American countries. La Compagnie Française was organised under the laws of France on July 2nd, 1895, to operate within two years a cable connecting without intermediaries the cables traversing the Caribbean Sea with the trans-Atlantic line. It was also agreed to lay a new cable line from Brest to a landing near Cape Cod, Massachusetts. The French Government agreed to pay the cable company an annual subsidy of 800,000 francs for 30 years in consideration of these operations. The bill of complaint says that the United States and Hayti Cable Company was organised on February 4th, 1895, as a West Virginia corporation, its capital being $10,000. Of this the sum of $1,000 was paid in. Its incorporators, the complaint says, were John W. Mackay, George G. Ward, Albert Beck, John W. Mackay, jun., and Albert Chandler.

The complaint charges that this company was formed at the instance of the French company in order to lay a few miles of cable out from Coney Island, which could be connected with the French cable from Hayti and the West Indies. This would allow the French corporation to escape the conditions exacted by the United States, namely, the waiving of exclusive rights in South American countries, and this Coney Island cable, it says, would serve "to maintain its monopolistic concessions" in the West Indies and South American countries, and fulfil its contract so as to still receive the subsidy. On July 9th, 1895, the complaint says, another company was incorporated under the laws of the State of New York with a nominal capital of $1,800,000. It was known as the United States and Hayti Telegraph and Cable Company, and its incorporators were Albert B. Chandler, Albert Beck, John Beattie, Edward C. Platt, John W. Mackay and George Clapperton. The object of this company, it is alleged, was to make a telegraph line from New York City to Coney Island and thence by submarine cable to the Isle of Hayti, as well as to run wires from this city through the States of Connecticut, Rhode

Island, and Massachusetts, and to various points on the New England coast. The United States and Hayti Telegraph and Cable Company, District Attorney Macfarlane alleges, is the successor in interest of the United States and Hayti Cable Company, and is controlled by the same interests and for the same purpose.

The complaint further says there is a cable Bill before the United States Senate, which was introduced May 29th, 1896. This is a very stringent measure, and the complaint says that the defendants are anxious to push along their plans before it becomes law. Mr. Macfarlane says the French Cable Company has chartered two ships, one of which, the *Francois Arago*, is at the submerged end of the connecting cable, off Hayti, and the other, the British steamship *Seine*, is now in American waters for the purpose of connecting a cable with a 10-mile line of cable run out from Coney Island. At John W. Mackay's office, late yesterday afternoon, it was said that Mr. Mackay had gone out of town. George Clapperton, his traffic superintendent, said: "We are charged with what we are not guilty of. Instead of creating a monopoly, what we are doing tends to break up a monopoly. Our answer is not ready yet, but I may say we believe that competing companies are at the bottom of the whole matter, though the suit is brought by the United States. What we are trying to do is to have direct cable connection between New York and the West Indies. To send a cablegram now from New York to the West Indies, it must first go over the Western Union wires to Florida, and by the International Telegraph Company from Florida to Havana, and beyond Cuba by Cuba Submarine, and further still, through the West India and Panama Company." Mr. Clapperton said one competing company was at the bottom of the case, but would not tell its name.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 21st. The Belgian Post and Telegraph Authorities, in Brussels, are inviting tenders until the 21st inst., for the supply of a quantity of galvanised iron wire, in three diameters, river cables, submarine cables, and copper wire. Tenders to be sent to La Bourse, Brussels.

Belgium.—October 21st. The Belgium State Railway authorities have fixed October 21st, as the last date for the receipt of tenders for the supply and erection of all the necessary plant required for a self-contained installation of electric lighting at the railway station at Arlon, for the lighting of the railway station offices, locomotive and waggon shops, locomotive shed, &c. Tenders are to be sent to the Bourse, Brussels, where particulars may be obtained.

Belgium.—October 21st. Tenders invited by the Belgian State Railway Authorities, in Brussels, for the supply of 81,130 metres of arc lamp carbons. Tenders to be directed to the Bourse, Brussels.

Belgium.—October 28th. The Société Nationale des Chemins de Fer Vicinaux, in Brussels, is inviting tenders for the conversion of about 23 kilometres of "Vicinal" railways in the Charleroi district, into electric lines on the overhead conductor system. Particulars may be had for 1 fr. from, and tenders to be sent to, the Société Nationale des Chemins de Fer Vicinaux, 26, Rue de la Science, Brussels.

Bradford.—Tenders are required by the borough electrical engineer (Mr. Gibbings), for a quantity of electrical meters—Aron, Frager, Edison, and Oulton-Edmondson. For further details see our "Official Notices."

Dublin.—From our "Official Notices" it will be seen that the Dublin Bread Company, Limited, wants tenders for a motor van.

France.—October 20th. The French Post and Telegraph Authorities, in Paris, are inviting tenders until the 20th inst., for the supply and laying of a 4-conductor submarine telephone cable across the channel, between France and England. Tenders to be sent to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Ireland.—October 19th. Tenders wanted by the Commissioners of Public Works, Dublin, for supply and erection of poles and one telegraph wire from Londonderry to Letterkenny, a distance of 24¾ miles; supply and erection of poles and two wires from Londonderry to Letterkenny, a distance of 24¾ miles; supply and erection of poles and one wire from Tooban to Letterkenny, a distance of 18½ miles; supply and erection of poles and two wires from Tooban to Letterkenny, a distance of 18½ miles (all to be according to Post Office standard specification); and making telephonic communication from Londonderry to Letterkenny. Further particulars from the secretary, Office of Public Works, Custom House, Dublin.

London.—October 26th. Tenders are wanted (*a*) for the supply of red fir telegraph poles, and (*b*) for creosoting the poles with 10 lb. or 12 lb. of creosote to the cubic foot, as may be directed, for the Postmaster-General. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E. Stuart, controller of stores, General Post Office, E.C.

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Roumania.—November 16th. The Municipal Authorities of Bucharest are inviting tenders for the supply and erection of two auxiliary steam engines at the hydro-electric central station at Grozaresti. Tenders to be sent to La Mairie, Bucharest, Roumania.

Spain.—October 17th. Tenders are being invited until the 17th inst. by the Municipal Authorities of Medina de Rioseco (Valladolid province), for the concession for the electric lighting of the town during a period of 20 years. Tenders are to be directed to El Secretario del Ayuntamiento de Medina de Rioseco (Valladolid).

Swindon.—October 26th. The Great Western Railway Company are prepared to receive tenders for the supply of stores, including telegraph apparatus, tools and drysalteries, electric light carbons, zinc, wire, telegraph poles, &c., &c. Full particulars were given last week in our "Official Notices."

Wolverhampton.—Tenders are invited for electric lighting, heating, and cooking plant for the Victoria Hotel. Particulars from Mr. T. J. Barnett, secretary, 25, Darlington Street, Wolverhampton.

CLOSED.

Belgium.—Four tenders were submitted to the Provincial Government Authorities for the contract for the electric lighting installation in the Palais des Academies in that city, the lowest being that of the Société d'Electricité (Bouckaert & Co.), Brussels.

France.—The French Post and Telegraph Authorities, in Paris, lately invited tenders for the supply of 594 tons of copper wire. The contracts have been placed as follows:—60 tons, 2 mm. diameter, the Usines Mouchel, Paris, at 97,050 francs; 60 tons, 2 mm. diameter, the Compagnie Française du Bi-metal, Paris, 97,940 francs; 60 tons, 2½ mm., the Usines Mouchel, 96,900 francs; 60 tons, 2½ mm., the Compagnie Française des Metaux, Paris, 97,140 francs; 54 tons, 3 mm. diameter, the Forges de Pontgibaud, Paris, 86,139 francs; 54 tons, 3 mm. diameter, Messrs. Lazare, Weiler & Co., Paris and Havre, 86,886 francs; 72 tons, 4½ mm. diameter, Compagnie Française des Metaux, 116.568 francs; 72 tons, 4½ mm. diameter, Messrs. Lazare, Weiller & Co., 116,280 francs; 51 tons, 5 mm. diameter, Compagnie Française du Bi-Metal, 81,549 francs; and 51 tons 5 mm diameter, to the Forges de Franche Compté, of Besançon, at 77,775 francs.

Mile End.—A contemporary states that the tender of Mr. Fife (£4,087 10s.) for the electric lighting of the Guardians' establishments has been accepted by the Mile End Guardian Board.

NOTES.

The Luminous Output of the Electric Arc.—At the recent Congress of the French Association for the Advancement of Science, Mons. Blondel presented a memoir on this subject. This memoir described experiments, by means of which the author had endeavoured to determine the total luminosity produced by an electric arc in terms of such constants as the intensity of the current, the voltage, the diameter, &c., of the carbons. These experiments were carried out jointly by Messrs. Laporte, Coster, and Jigouzo. Up to the present, the results obtained have furnished three sets of curves, one for 10 amperes, one for 8 amperes, and one for 6 amperes. Other experiments were conducted, with a view to obtaining information respecting the law of the variations of the luminous flux in terms of the intensity of the current for the same pair of carbons. The function obtained was parabolic, and this confirms the results arrived at by the commissions appointed to make experiments during the recent exhibition at Antwerp. Soft carbons give more light than the hard ones. The paper should certainly be carefully studied by those of our readers who are specially interested in such matters.

Errata.—In our brief report (on page 442, October 2nd) of the paper on "Reostene," read before the B.A. meeting by Messrs. Harker and Davidson, several printer's errors occurred. In paragraph 3, line 4, for "insulated oil," read "insulating oil." In paragraph 7, line 7, in the sentence "Selecting at random . . . . a coil of 14 S.W.G. decreased 1 per cent," for "1 per cent." read "·1 per cent." The last paragraph but one of the paper should read on as one sentence, without the full stop after the word solder.

A New Insulating Material.—Ambroin is the name given to a new insulating material, which is described in the *Electro-techniker*, Vol. xv., p. 228. This material is made from specially prepared fibrous silicates thoroughly soaked and mixed with fossil resin, and then subjected to an exceedingly high pressure. The product is thus closely allied to vulcanite, to which it has a great resemblance, except that it is somewhat more brittle. Ambroin can be prepared of any required colour. Usually the acid quality is light brown, and the quality for turning of a deep black colour. The special quality for electro-technical purposes appears to be dark brown, or brown marbled with black. Ambroin has been used for the manufacture of a great variety of articles for which horn, bone, celluloid, vulcanite, &c., have hitherto been used. Tubes, plates, insulating rollers, collector rings, boxes for safety fuses, buttons which compare favourable with those made of horn or ivory, finely turned and polished boxes, rosettes, and many other articles. Among the special properties of ambroin are its capability of being moulded without contraction, of forming perfectly homogeneous joints, and of being easily worked; it can be cut, turned, bored, welded, stamped, and by a special process soldered and cemented. It possesses, according to experiments made in the laboratory, a specific resistance of 1,000 million ohms; and according to these, a piece of ambroin 0·34 mm. thick was not perforated by a D.P. of 5,000 volts. The material appears to be unaffected by the weather, a result to be expected from the fact that its constituents have been exposed to the weather for centuries. As to its fireproof qualities, the ordinary kinds will stand a temperature of 400° C.; special kinds for switchboards, &c., will stand a temperature of 1,500° C. Its behaviour with acids is also very satisfactory. Sulphuric acid, and concentrated nitric acid, 45° B., do not attack it at 80° C. Nitric acid of 24° B. produces a slight superficial nitrification. Aqua regia, as well as acetic acid, up to 50 per cent., have likewise no action on the material. Moderately strong alkalies (up to 25 per cent.) do not injure the special kinds of ambroin already mentioned. The coefficient of heat expansion of ambroin is so small, that it has been proposed to apply it for the measurement of the European degree. It appears that this new insulating material will be an important addition to those already in use for electro-technical purposes, though, by virtue of its special properties, it will probably rather supplement than supplant them.

The Heilmann Locomotive.—The *Railroad Gazette*, of New York, reprints an article from the *Transactions* of the French Society of Civil Engineers, by M. H. de Grièges. Our northern contemporary, the *Practical Engineer*, reprints the article and comments upon it, characterising the engine as a bold step, and the fundamental idea as, apparently, sound and worth prosecuting. It is pointed out, however, that the 1,300 to 1,400 horse-power expected to be developed from the fire-grate of 36 square feet requires a wheel base of 45 to 50 feet, and this is noted as about the same as that necessary to develop an equal power in the steam locomotive, the wheel base of which for 600 to 700 H.P. would only be about 23 feet. Our contemporary, moreover, points out the apparent absence of coal space on this new Heilmann engine, or of water storage, and, generally, the whole thing seems to be altogether too unwieldy for the end in view. Nor can we think it is calculated to forward the cause of electric traction. That it will be a failure we do not aver. "Anything," we believe, Brunel once said, "that will turn round will do to draw a train," and the Heilmann engine ought certainly to turn round with its six cylinders. It is also already reported that the Western Railway Company of France will not commit itself to one system of electric traction, but will equip the St. Germain line on the Ouest to Grand Ceinture, about 2¼ miles, with a trolley line, and experiment thereon, it is hoped, with conclusive results.

America and Li Chung Tang.—The great Chinaman who left us recently for America, and carried away impressions of all he had seen but said so little, is compared by the *Scientific American* to Bismarck. How a peaceable man like Li will relish being compared to one of the most warlike men of the age, we cannot say, but we would advise a less doubtful compliment if Americans wish to secure orders from the Chinese Government. America lies so near to China, that there ought to be a good prospect of trade between the two countries, and the chief bar to this seems to be in America's illiberal treatment of poor John Chinaman in the Western States. European nations who put a duty on American goods are denounced as foolish, but duties laid in America on goods from Europe are far heavier, and are held up as evidences of American genius; while the present presidential contest now in full swing is turning entirely on the question of exclusive tariffs and debt repudiation, and yet the *Scientific American* wants China to go in for American goods, and pay full money to a country which poll-taxes Chinamen, and wants to pay its debts in 53-cent dollars. In the face of a national commercial policy like this, it seems a trifle ridiculous to talk of pushing foreign trade, and of opening up foreign markets, while keeping their own shut up, and even taxing the travellers of the nation with whom they seek to do business. The whole thing is too ridiculous. Could our contemporaries anticipations be at once realised, the amount of business that could be given out by China would employ the workshops of the whole world, but no such thing will happen. The trade of China will not in a moment flow in other channels, and fortunately for us all that it will not do so, for a sudden flood of business could have but a disastrous effect. The desirable end of the Viceroy's tour would be a gradual and steady opening up of the great unknown country. China is in a condition to absorb enormous quantities of manufactured goods, but we must also recognise her vast stores of coal and iron, and realise that before many years, if the example of Japan be followed, China may be manufacturing her own steel rails under the supervision of a mere handful of Europeans and Americans. It is all very well to hammer down the gates of China, but it it just as well to remember that a gate opened to let in the outer world may equally well be used to let out China's teeming millions upon that same outer world. The Huns under Attila would be a mere nothing to the invasion by the yellow man. The old saying, "Let sleeping dogs lie," has a meaning yet, but for present gains we all seem disposed to risk the venture.

Electric Blasting.—A valuable tribute is paid by *Arms and Explosives* in its current issue to the efficacy and superiority of the electric ignition of blasting explosives. This paper is always distinguished by the high scientific knowledge which is displayed in its pages, and by the absolutely impartial attitude with which it regards all questions of moment to the trades it represents. The temptation in a paper representing the explosives industry would naturally be to belittle electrical systems of blasting, and to belaud such systems as depend entirely upon the use of explosives. After a careful examination into the respective merits of such systems, however, we find *Arms and Explosives* plumping strong for the electrical system of igniting blasting charges, whether in the getting of coal, stone, or other materials. The system of electric blasting, which may depend upon the use of high tension or low tension currents, is distinguished from the alternative plan afforded by the safety fuse, inasmuch as it consists in supplying the initial source of heat required to bring about the explosion of the main charge by means of an electric current, instead of by means of a match, or other special device, by which the end of a time-fuse is lighted; while in the case of the time-fuse the igniting device is applied to a short protruding end and the workers precipitantly retire to a safe distance to await the explosion. In the case of the electrical fuse there are wires communicating from the working face to a position of safety from which, when all is clear, the current is turned on. The danger of accidents to the men by premature explosion—by hang-fire, or by ignition of any explosive gas which may happen to be in the workings—are not possible with electric shot firing, and it is for these reasons that the mines inspectorate appointed by the Government are strongly recommending the adoption of electric blasting generally, and especially in coal mines. We have often advocated the general adoption of electrical firing; and whenever we have heard of dreadful accidents have thought it our duty to animadvert upon the subject. It is gratifying to find our views so thoroughly supported now by the leading organ of the explosives industry.

Efficiencies of Non-Conducting Coverings.—The Boston Manufacturers' Mutual Fire Insurance Company have issued a report, made by Mr. C. L. Norton, upon various forms of pipe clothings for heat conservation. Two sets of experiments made with steam at 381·7° F. and 239·4° F. with several substances, gave practically the same order of merit, a certain "Nonpareil cork" having not only the minimum thickness of ·90 inch, and the minimum weight of 21 ounces per foot of length, but showing least loss of heat per square foot of pipe, viz., 3·04 units per minute. The next in order of merit were manganesia, 1·12 thick, with 3·4 units; 1·25 inches thick of air cell, with 3·40 units; 1·12 of magnabestos, with 3·84; 1 inch of fire felt 3·99, and 1·25 calcite, with 5·02. At the lower temperature the losses were just about halved in each case, and the bare pipe lost four times the amount lost by the cork. Again, the fire felt and the magnabestos weighed 46 and 48 ounces, against the 21 ounces of cork, and even the air cells weighed 36 ounces. The method of measuring the loss of heat was to fill the test piece with oil, and heat it up by a wire, keeping the oil in circulation by a propeller. The readings of the currrent necessary to maintain the temperature constant, at once show the rate of heat loss, and it was found easy to maintain a constant temperature. According to Prof. Ordway's experiments, the best substances as non-conductors are liable to become charred, and are therefore more or less inadmissible according to the temperature of the steam. Such substances are wool, feathers, cotton, hair, felt, charcoal, paper, chaff, &c. Again, one must guard against substances such as certain forms of slag wool, which are apt to consolidate by vibration, and so become much less efficient. As a mere matter of the best all round article, the best would seem to be magnesia, which, with its 1·12 of an inch in thickness, and only weighing 24 lbs. per foot, lost only 3·4 units, being nearly as good as the cork, and only two-thirds as heavy as the air cell material of equal efficiency otherwise. All coverings should be kept dry, for still water conducts heat eight times as rapidly as air; but this is not the only loss due to dampness, because there is the greater loss which arises from the evaporation of any accidentally introduced water with the absorption of so much latent heat in the process.

Personal.—Messrs. H. R. J. Burstall and E. W. Monkhouse have started business as consulting engineers at 14, Old Queen Street, Westminster, under the style of Burstall and Monkhouse. Mr. H. R. J. Burstall, Assoc.M.Inst.C.E., Memb.Inst.Mech.E., M.I.E.E., served his time as a mechanical engineer (marine). After filling a position in the office of a consulting engineer in the City, 1886—1888, superintending marine and other engine construction and repair, Mr. Burstall was engaged in September, 1888, by Prof. Kennedy to take charge of his Westminster office, and has been his principal assistant since 1890.

Mr. E. W. Monkhouse, who is an Assoc.Memb.Inst.C.E., served his time as a mechanical engineer, and was formerly with Fraser & Chalmers, of Erith, and afterwards with the Maxim-Nordenfeldt Company. He was appointed second engineer (in the Westminster Company) at Eccleston Place, when the station was started, and afterwards became superintendent of mains of the W.E.S. Co., and during this time he changed over the system from two-wire to three-wire, without stoppage of the system. In 1894, he was appointed electrical engineer for Edinburgh, laid all the mains without a contractor, and superintended the erection of the plant in the station.

We wish them a full measure of success in their new work.

Lightning Fatality.—A footballer named Thomas Watson, and about a dozen others, were struck by lightning on Monday in the neighbourhood of Liverpool just before a match was timed to commence. Watson was instantly, killed, but all the others recovered.

Appointment.—Mr. Thomas Heaketh, of Blackpool, has been appointed assistant electrical engineer at Hampstead, in the place of Mr. Hansom, resigned.

Lectures.—At Christ Church Schools, Denmark Road, Moss Side, on Monday next, October 19th, 1896, a lecture will be delivered on "The Röntgen (or X) Rays and their Application," illustrated by experiments, limelight views, &c., by Mr. F. S. King, B.A., LL.B., T.C.D., assisted by Messrs. Bernard Hunt (Demonstrator in Physics and Electricity, Royal Technical Institute) and Leonard W. Chalk.

Prof. Goodman lectured on "Autocars" in the Engineering Department of the Yorkshire College, Leeds, on 9th inst.

Lightning Conductors at St. Paul's.—A correspondent, "R. S. U.," of the *City Press*, writes as follows:—"In the *Philosophical Transactions* of 1769 there was made a proposal for a method to secure St. Paul's from fire 'by means of electrical conductors, fixed up in a manner that is now generally known.' Perhaps a reader can inform me whether these electrical conductors were affixed to the Cathedral at this time, and if so, what was their nature, and whether they still do duty? It would be interesting to learn which was the first City building furnished with lightning conductors."

Appointment Vacant.—The Shoreditch Vestry invite applications for the post of resident electrical engineer at a salary of £250 per annum. For particulars, see our "Official Notices."

The Electric Lighting of the "Fram."—In a recent issue we gave a few details from the daily press regarding the *Fram* installation. The Editor of the *Elektroteknisk Tidsskrift* (published at Christiania) asks us to state that this information first appeared in his journal.

Fatality.—One man was killed and two were injured, on Wednesday morning, at the station which is being put down opposite Chancery Lane by the Central London Railway Company. They were at work at the shaft when a "skip" full of earth broke away from the steam crane and fell upon one, killing him, and injuring the others.

NEW COMPANIES REGISTERED.

Beacon Engineering Company, Limited (49,607).—Registered October 5th with a capital of £5,000, in £5 shares, to carry on the business of ironfounders, mechanical engineers, manufacturers of all kinds of machinery, brassfounders, metal workers, electrical engineers, consulting engineers, boiler makers, machinists, iron and steel converters, &c. The subscribers (with one share each) are: G. H. Hollingworth, Bredbury House, near Stockport, engineer; E. G. Constantine, 32, Victoria Street, Manchester, engineer; E. F. Stanley, Monmouth House, Waterloo, merchant; C. H. Lawson, 128, Acomb Street, Manchester, engineer; L. W. Windle, 165, Denmark Road, Manchester, assistant; Mrs. Constantine, 3, Seymour Terrace, Old Trafford; Mrs. R. Hollingworth, Bredbury House, near Stockport. The regulations of Table "A" mainly apply. Registered by Jordan & Sons, Limited, 120, Chancery Lane, London, W.C. Registered office, 32, Victoria Street, Manchester.

Coventry Motor Company, Limited (49,611).—Registered October 5th, with a capital of £10,000 in £1 shares, to manufacture, sell, let on hire, and deal in automotor cars, carriages, cabs, omnibuses, tramcars, railway coaches, waggons, cycles, velocipedes, perambulators, &c., and to carry on the business of electrical, mechanical, and general engineers, machinists, fitters, tool makers, &c. The subscribers (with one share each) are:—H. W. Jordan, 120, Chancery Lane, W.C., agent; W. T. Jones, 17, Penford Street, S.E., clerk; H. C. Newman, 230, Lancaster Road, W., clerk; G. C. Hayward, 6, Torriano Gardens, N.W., clerk; W. Jordan, 55, Highbury Park, N., agent; F. Sheilds, 8, Bell Yard, Temple Bar, director; W. C. Gurney, 22, Stanley Road, N., clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Remuneration as the company may decide. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, Conduit's Yard, Coventry.

Electric Free Wiring Syndicate, Limited (49,613).—Registered October 6th with a capital of £1,000, in £1 shares, to carry on the business of electricians, mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The subscribers (with one share each) are:—J. B. Atherton, Manhattan, Rainhill, Lancashire, manufacturer; G. H. Nisbett, Ashfield, Hington, Lancashire, electrical engineer; F. J. Lealie, 15, Union Court, Liverpool, solicitor; A. Ellis, Electricity Works, Bolton, engineer; C. O. Grinstrod, 11, Knowsley Road, Rock Ferry, gentle-

man; A. G. Haptie, 32, Hereford Road, Seaforth, cashier; A. Ruckley, 8, York Road, Seacombe, clerk. The number of directors is not to be less than two, nor more than six; the subscribers are to appoint the first. Remuneration as the company may decide. Registered by F. J. Leslie & Co., 15, Union Court, Liverpool.

Laing, Wharton & Down, Limited (49,645).—Registered October 8th, capital £30,000, in £1 shares (6,000 5 per cent. cumulative preference), to acquire the business of electrical engineers and contractors carried on by G. A. Wharton, A. F. Davies, and F. J. Down at 82A, New Bond Street, and elsewhere, as Laing, Wharton and Down, to enter into an agreement with the said vendors, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and electrical apparatus manufacturers. The subscribers (with one share each) are:—A. F. Davies, 82A, New Bond Street, W., electrical engineer; C. J. Wharton, 10, Greaton Road, Harrow, engineer; H. K. Smith, Kingsfield, Watford, engineer; F. J. Down, Melton Road, Harpenden, engineer; W. Howard, 27, Clement's Lane, E.C., chartered accountant; A. W. Leipschen, 1, Frederick Place, Old Jewry, E.C.; Geo. Cruikshank, 1, Frederick Place, Old Jewry, E.C. The number of directors not to be less than three nor more than seven. The first are F. J. Down, A. F. Davies, and J. Eck. Qualification £100; remuneration £250 per annum. Registered office 82A, New Bond Street, W.

Fleetwood and District Electric Light and Power Syndicate, Limited (49,666).—Registered October 9th, with a capital of £20,005 in £1 shares, to carry on at Fleetwood, Lancashire, or elsewhere, the business of an electric light company in all its branches, and to construct, lay down, establish, fix and carry out all necessary cables, wires, lines, accumulators, lamps and works. The subscribers (with one share each) are:—S. E. Hubbard, 20, Ely Place, E.C., solicitor; A. Slatter, 7, Ridgmount Street, Bedford Square, electrical engineer; C. W. Sax, 2, Woburn Square, W.C., electrical engineer; A. G. Seaman, Kananuk, East Molesey, electrical engineer; T. E. Ingoldby, 12, Montagu Street, Russell Square, electrical engineer; E. A. M. Winter, 53, Charterhouse Street, E.C., clerk; J. Atherton, 11, Charing Cross Road, W.C., electrical engineer. Registered without articles of association. Registered office, 20, Ely Place, Holborn.

Meyrick & Holt, Limited (49,684).—Registered October 10th with a capital of £3,000, in £5 shares, to acquire the business carried on by G. Meyrick and E. Holt, as "Meyrick and Holt," and to carry on the business of motor, cart, waggon and carriage manufacturers, electricians, machinists, fitters, founders, saddlers, rubber manufacturers, &c. The subscribers (with one share each) are:—G. Meyrick, 21, Buckingham Street, Rochdale, coach-builder; E. Holt, 118, Fenton Street, Rochdale, coach-builder; J. Buttery, Red Lumb, Rochdale, manufacturer; S. A. Heywood, Ivy Cottage, Red Lumb, Rochdale, manager; Mrs. E. Heywood, Ivy Cottage, Rochdale; Mrs. M. Meyrick, 21, Buckingham Street, Rochdale; Mrs. M. Holt, 48, Fenton Street, Rochdale. The number of directors is not to be less than two, nor more than five; qualification 20 shares. Registered by Hooper & Son, 69, Ludgate Hill, E.C.

CITY NOTES.

The Electric Lighting Extension Syndicate, Limited.

This company has been formed with a capital of £5,000, in £1 shares, for the purpose of acquiring sole rights in Bastian & Hodges' invention relating to prepayment electricity and other meters, and for various other purposes connected with the lighting of buildings. The chief aim of [the syndicate will be to develop the use of an automatic penny-in-the slot electricity meter. The enormous number of applications and inquiries that continue to pour in upon the London and provincial gas companies for automatic gas meters is used to show the magnitude of the field for electricity automatic meters. While we should be only too glad to hail the advent of some means of extending electricity supply, it is impossible for us to share the enthusiasm of the promoters of the Automatic Electricity Meter Syndicate. We must credit the syndicate with a worthy object when they seek to develop the use of electricity among the poorer classes, but do they expect that desideratum to be reached by a pre-payment meter? Poor people have not the electric light near their houses, and could not get it if they wanted it, whereas gas mains are laid everywhere. Before the penny-in-the-slot meter could be successful, electric light works would need to be trebled and quadrupled, to cope with the load that would arise. Such extensions would take so much time and capital, that we are afraid some years must elapse before the promoters could hope to see their electricity meters used to one-tenth of the extent that automatic gas meters are employed, even if they succeeded in convincing central station men that the pre-payment meter was to be their salvation. To spread electric lighting among the poorer classes needs something more than an automatic meter, altogether we are afraid the prospectus before us is too anticipatory.

Newport Corporation Accounts.

The result of the first year's working is a gross profit of £224, which, after setting aside £927 for interest on loans, and £707 for depreciation and sinking fund, leaves a deficit on the year's working of £1,634. The cost of working is distinctly low for the first 12 months, and with an accession of consumers and a better load on the present plant, the second year ought to see the works well on the way to prosperity.

The cost of production is as follows:—

	1893.	1894.	1895.
Total capital invested ...	—	—	£34,562
Number of units sold	—	—	91,557
Number of lamps connected ...	—	—	7,278
Revenue from sale of current...	—	—	£1,379
Net loss	—	—	£1,410
Average price obtained per unit	—	—	3·61d.

Cost of Production.	£	s.	d.	Per unit.
Coal	251	0	0	·66d.
Oil, waste, water, and engine room stores	171	0	0	·45d.
Salaries and wages at generating station	355	0	0	·93d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	29	0	0	(Works' cost) 2·11d. ·07d.
Rates and taxes	83	0	0	·22d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	336	0	0	·88d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£1,225	0	0	3·21d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	1,379	0	0	—
Meter rents, &c.	70	0	0	3·61d.
Sale of lamps	—			—
Total	£1,449	0	0	3·61d.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·61d.; works' cost, 2·11d.

The Leicester Corporation Accounts.

The Leicester Corporation electric lighting accounts are made up half-yearly, but to bring them into line with our usual methods, we have preferred to take the two half-yearly accounts together. Indulging in a mere fit of curiosity, however, and comparing the two accounts together, some striking facts are evident. For the six months ending December, 1895, 50,928 units were sold, and the total cost of fuel was £137 14s., which figures out at ·65d. per unit, a very satisfactory result, but, during the same period, "oil, waste, water, &c.," cost no less than £115, which is ·54d. per unit. Apparently "waste" must have been rather abnormal during that half-year, for in the following six months, when nearly 8,000 more units were sold, "Oil, waste, water, &c.," stands at the more rational figure of £49 10s. No doubt the difference between the two items is capable of a very easy explanation, but the disparity is certainly very remarkable. We have already given the main points in the year's working, but in view of the analysis which is given below, it will be interesting to repeat them:—For the half-year ending June 30th last there was a loss, after charging £584 on the sinking fund account, of £723 0s. 5d., after taking credit for £151 14s. 6d., the profit from the electric lighting fitting business. This amount, together with £1,337 17s. 8d. lost on December 3rd last, made a total loss in connection with this department of £2,060 18s. 1d. The total amount which had been paid on the sinking fund was £1,882. The revenue from the sale of electric current had risen from £671 to £1,467 12s. 6d., an increase of £796. The total revenue was £1,670, against £963, a total increase of £707. The expenditure had got up from £863 to £1,254 14s. 8d., the principal portion being for wages, while they had £68 3s. to pay for taxes, which they had not to pay before. The balance carried to profit and loss account was £415 11s. 8d. The net loss up to December 31st, 1895, was £1,337, and the loss for the half-year ending June 30th was £723, making a total loss of £2,060. This half-year they had more than double the number of consumers, and in the next half-year the profit would counterbalance the loss on the first half-year, making a level balance-sheet for the year. A reduction in the

price of the current from 6d. to 5d. per unit is to be made from January 1st next.

The foregoing is taken from the Electric Lighting Committee's report, and it shows, at any rate, that in spite of the somewhat heavy loss, the members of the Committee have confidence in the future of their undertaking. The cost of production for the year ending June 30th is as follows:—

	1893.	1894.	1895.
Total capital invested	—	—	£42,748
Number of units sold	—	—	109,633
Number of lamps connected ...	—	—	—
Revenue from sale of current...	—	—	£2,741
Net Revenue	—	—	—
Net loss...	—	—	£2,060
Average price obtained per unit	—	—	6·03d.

Cost of Production.	£ s. d.	Per unit.
Coal	344 0 0	·76d.
Oil, waste, water, and engine room stores	165 0 0	·36d.
Salaries and wages at generating station	1,037 0 0	2·28d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	274 0 0 (Works' cost 4·00d.)	·60d.
Rent and taxes	—	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	346 0 0	·76d.
Depreciation of buildings and plant account	—	—
Renewal fund account	—	—
Total	£2,166 0 0	4·76d.

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current	2,741 0 0	—
Meter rents	86 0 0	6·03d.
Profit on fittings department.. ..	418 0 0	—
Total	£3,245 0 0	6·03d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·76d.; works' cost, 4·00d.

Elmore's French Patent Copper Depositing Company, Limited.

A MEETING of this company was held on Monday at Winchester House, Mr. J. H. Duncan, the receiver and liquidator, presiding.

The CHAIRMAN said that under the scheme of reconstruction they had issued certain bonds, which were all debentures upon the English company, which held all the founders' shares in the French company. These shares were not, as yet, in receipt of any dividend; and if he had not been in the way it would have been open for anyone to have begun proceedings against the company on the bonds. Meantime, he had acted as buffer, but the inspector of the Board of Trade wanted to know why he did not close matters. The business in France had been taken in hand by French capitalists in a way that could not have been done on this side. Although numerous difficulties had been encountered, they had paid two dividends, amounting to 5 per cent. on the share capital, in addition to paying 6 per cent. interest on the bonds. The founders' shares did not benefit until 10 per cent. had been paid, and reviewing the general prospects, he expressed his opinion that there was reasonable expectation that the founders' shares would in time become valuable.

A resolution was ultimately passed requesting Mr. Duncan to continue in office subject to the approval of the Board of Trade.

City of Birmingham Tramways Company, Limited.

ON Wednesday the list of applications opened for the issue of £220,000 4 per cent. first mortgage debentures of £100 each (at £102), and 24,000 cumulative 5 per cent. preference shares of £5 each (at £5 4s.) in this company. The 60,000 ordinary £5 shares have been allotted at par. The company has been formed for the purpose of acquiring tramways in the city of Birmingham and neighbourhood, and for the development of the tramway system within that area. Messrs. William Mackenzie, of Toronto, president of the Toronto Railway Company, and James Ross, of Montreal, vice-president and managing director of the Montreal Street Railway Company, have acquired from the Birmingham Central Tramways Company, Limited, the entire undertaking of that company for the sum of £485,000, and certain other payments, and by a contract dated October 1st, 1896, and made between Messrs. Mackenzie and Ross of the one part, and this company of the other part, those gentlemen agree to re-sell the tramways and property to this company as from October 15th, 1896, at the sum of £500,000, being the amount of the purchase money before mentioned, and the estimated sums payable for the costs, charges, and expenses incurred in and incident to the negotiations for the purchase and the formation of this company up to October 15th, 1896. The existing tramways of the Birmingham Central Tramways Company consist approximately of 27 miles of route line, held upon several leases from the Corporation, determining in 1907 and 1911 respectively, and of 14½ miles of route line outside the city boundary, held upon the usual conditions imposed by the Tramways Act of 1870. Terms have been approved by the city authorities for the surrender of the existing leases, and the grant of new leases for 21 years on a satisfactory basis as to rental, and for the substitution of an improved motive power.

Hitherto these tramways have been worked by four different systems of traction, namely, horse, steam, cable, and electric storage batteries, but, with the exception of the cable, all these have proved unsatisfactory; it is therefore proposed to replace them by an improved method of traction, the cable being retained for the present, and further to develop the system by connecting the existing tramways within the city, extending the lines in the outlying districts, and by constructing such other lines as may be required for the adequate accommodation of the public.

It is the intention of the company to adopt electric traction over the entire system. The directors are:—William Mackenzie, Esq., Toronto, Canada, president of the Toronto Railway Company; James Ross, Esq., Montreal, Canada, vice-president and managing director of the Montreal Street Railway Company; Henry Buckley, Esq., chairman Birmingham Electric Supply Company, Limited; William Neale, Esq., chairman of the Birmingham Central Tramways Company, Limited. The secretary is Mr. William Holmden, and the registered offices are at 119, Colmore Row, Birmingham. The trustees for the debenture-holders are Messrs. J. A. Christie and James Ross.

Monte Video Telephone Company, Limited.

THE directors, in their report for the year ended July 31st last, state that the accounts show a net profit for that period of £5,727, after providing for all working expenses in Monte Video and London, and after writing off amounts for bad debts and depreciation of office furniture. This amount, added to the sum of £710 brought forward from last year, leaves an available balance of £6,438. During the year a marked improvement has been made in the company's service by the adoption of a new microphone. The whole outlay of this and other extensive additions to the plant has been charged to working expenses. The number of subscribers is gradually increasing, and the general position of the company is satisfactory. The directors recommend the payment of a dividend of 4 per cent. on the preference share capital of the company, absorbing £5,600, and leaving the sum of £838 to be carried forward to next year.

Brazilian Submarine Telegraph Company, Limited.—The accounts of this company, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30th, 1896, and also the payment of a bonus of 2s. per share, both free of income-tax, which, together, will amount to £32,500, leaving a balance of £31,060, of which amount £20,000 has been placed to the reserve fund, and £11,060 carried forward. For the purpose of paying the above dividend and bonus on the 29th inst., the register of transfers will be closed from October 20th to 28th, both days inclusive.

The St. James's and Pall Mall Electric Light Company, Limited.—The sale of electricity by the St. James's and Pall Mall Electric Light Company, Limited, for the quarter ending September 29th, 1896, representing the supply at 6d. per unit, amounted to £10,084, as against £7,402 at the same rate for the corresponding period of 1895.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 2s. 6d. per share, free of income-tax, being at the rate of 2½ per cent. per annum, for the quarter ending September 30th, 1896, such dividend to be payable on and after the 24th inst.

The Indo-European Telegraph Company, Limited.—The board has declared an interim dividend for the half-year ended June 30th last at the rate of 5 per cent. per annum, free of income-tax, payable on and after November 1st next. The transfer books will be closed from October 26th to 31st.

Submarine Cables Trust.—This company has issued a notice to the effect that on and after October 15th, the sum of £2 7s. 6d. on account of the coupon due October 15th, will be paid by Messrs. Glyn, Mills & Co.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending October 11th, 1896, were £965; week ending October 13th, 1895, £916; increase, £49; total receipts for half-year, 1896, £13,681; corresponding period, 1895, £12,774; increase, £907.

The Liverpool Overhead Railway Company. The receipts for the week ending October 11th, 1896, amounted to £1,076; corresponding week last year, £1,118; decrease, £42.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 9th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,895.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Oct. 7th.	Closing Quotation, Oct. 14th.	Business done during week ended Oct. 14th, 1896. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	8½ — 9½	8½ — 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	50 — 53	50 — 53	52	50
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	96 — 97	96 — 97	97	96⅝
2,993,560£	Do. do. Defd.	Stock	...	...	...	9 — 9½	8¾ — 9½	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	14¾ — 15¼	14¾ — 15¼	...	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	4 %	3¼ — 3¾	3¼ — 3¾	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	145 —150	145 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	1½%	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	11½ — 12½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	18½ — 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	...	4½%	4½%	107 —110 %	107 —110%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2½%	9½ — 10	9½ — 10	9⅝	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	6½%	17¾ — 18½	17¾ — 18½	18¼	17¾
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18½ — 19½	18½ — 19½	18⅝	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	131 —134	131 —134	133½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	7 %	17¾ — 18¼	17½ — 18	18⅛	17⅞
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 — 104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	130 —133	130 —133	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	102	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114 %	110 —113 %	111¾	111
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	4½%	10⅞ — 11½	10¾ — 11½	11⅛	10¾
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17⅞ — 18½	17½ — 18	18⅛	17¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	8⅝%	10 %	23½ — 24½	24 — 25	24⅛	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	52 — 53	52 — 53	53⅜	...
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	7⅜ — 7⅝	7½ — 7⅝	7 9/16	7
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	17⅝	17⅜
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	18	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅞ — 7⅛	6⅞ — 7	6⅞	6⅝
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —109	106 —109	107⅜	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	11/16 — 13/16	11/16 — 13/16	¾	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3½ — 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	5 — 6	5 — 6	...	...
238,360£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105	102 —105	...	...
36,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	½ — 1½	½ — 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	98 —103	98 —103	...	...
54,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8½ — 9	8½ — 8¾	8¾	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	...	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2½ — 2⅝	2½ — 2⅝	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	⅞%	⅞%	1½ — 1⅝	1⅛ — 1⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½ — 12	11½ — 12	11⅝	11½
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ — 10½	9½ — 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9½ — 10	9½ — 10	10	9⅞
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	7½ — 8	7¾ — 8¼	8	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	...	4½%	114 —117	114 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	16 — 17	16 — 17	16⅝	16 1/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18½	17½ — 18½	17¾	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —135	131 —135	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	...	*nil*	8½ — 9½	8½ — 9½	...	...
20,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	...	6 %	13¾ — 14¼	13¾ — 14¼	14 1/16	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	5½ — 6½	5½ — 6½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2½%	3 %	4 %	12½ — 13½	12½ — 13½	13 1/16	13
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	3½ — 4½	3½ — 4½	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	121 —124	121 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	11½ — 12½	11½ — 12½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	11½ — 12½	11½ — 12½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅜	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	106 —109	106 —109	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	4 %	5 %	7 %	10½ — 11½	10½ — 11½	11 3/16	11

* Subject to Founder's Shares.

‡ Unless otherwise stated all shares are fully paid.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

† Quotations on Liverpool Stock Exchange.

‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Oct. 7th.	Closing Quotation Oct. 14th.	Business done during week ended Oct. 14th, 1896. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 %	2½%	...	⅞ — 1⅛	⅞ — 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	3 %	...	1⅜ — 1⅝	1⅜ — 1⅝	1½	...
125,000‖	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	110 —113	110 —113	111	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	97 — 101	97 —101	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	10¼ — 10⅝	10 — 10⅛	10⅛	...
207,649	Do. do. do. £4 paid	10	...	...	...	4⅛ — 4⅜	4⅛ — 4⅜	4¼	4 3/16
630,000‖	City and South London Railway	Stock	1 1/16%	1½%	1 5/16%	48 — 50	50 — 52	51½	49
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %	*nil*	*nil*	2 — 2¼	2 — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅞ — 2¼	1⅞ — 2¼	...	...
17,139‖	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	103	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1½ — 1⅝	1½ — 1⅝	1⅝	1 9/16
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½ — 3	2½ — 3	2 15/16	2⅝
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜ — ⅝	⅜ — ⅝	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	¼ — ½	¼ — ½	...	...
9,600‖	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½ — 11½	10½ — 11½	...	...
10,000	Hanley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	18 — 19	17½ — 18½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	22 — 23	22 — 23	22	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108xd	105	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13 7/16 — 13 9/16	13 7/16 — 13 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅞ — 17⅜	16⅞ — 17⅜	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	40 — 43	39 — 42	41	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000‖	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8½	7⅞ — 8¼	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%/‖; 1891—7%/‖ 1890—8%/‖

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7, £5 (fully paid), 9⅝.
Electric Construction Corporation, 6 % Debentures, 104—107.
House-to-House Company (£5 paid), 4—4⅛.
Do. do. 7 % Preference, of £5, 8½—9.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10—10½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅜.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (September 24th, 1896).

APPLIED ELECTRO-CHEMISTRY.

By JAMES SWINBURNE.

Cantor Lecture II.—Delivered before the Society of Arts, May 4th, 1896.

(*Concluded from page 477.*)

If the chemical pressure of the cell is higher or lower than the actual, so that the cell heats or cools on discharging, it might be said there must be something corresponding to glorified Peltier, Seebeck, or Thomson effects (it is difficult to remember which of these effects is which) between the metals and its electrolyte, and between the electrolytes, if there are two. But the algebraic sum of these differences taken through the cell must be zero; so the generation of heat, or its disappearance as a whole, must be regarded as chemical, or in some other way. Some day the theory of ions may be worked out on circuital principles. In the meantime I will go back to the usual way of discussing dissociation.

Dissociation.

Not so very long ago it was supposed that in aqueous solutions the water conducted the electricity, oxygen and hydrogen being given off in the nascent state. The nascent gases were then supposed to react on the substances in solution, oxidising and reducing them. Recently, however, as already mentioned, the theory of solutions and of electrolysis has made enormous strides, especially in Germany. The names of Hittorf, Ostwald, Arrhenius, van t'Hoff, and especially of Nernst are more particularly identified with this development.

Too much space has been already given to the theory, or, rather, to one or two details of theory, to leave room for a long account of recent ideas of electrolytic dissociation. The theory is, that when a body is dissolved in a solvent, its molecules are moving as they would be in a gas. The mean free path of the molecules must, of course, be enormously smaller in a solution; and, I believe, that has been put forward somewhere, as an objection to van t'Hoff's theory. Under certain assumptions, however, the figures work out right. If a small quantity of sugar, say, is dissolved in water, and the solution is separated from pure water by a diaphragm, through which the sugar cannot be diffused, water will diffuse into the sugar side of the vessel. If it is closed, water will come in, until a certain pressure is produced. This is the osmotic pressure, and it is found to depend on the number of molecules of sugar per cubic centimetre of liquid. Solutions with the same number of gramme equivalents per litre of different non-electrolytes give the same osmotic pressure, and the pressure corresponds to the pressure they would give as gases occupying the volume of the whole solution. Solutions containing the same number of gramme equivalents per litre also give the same vapour tension, and the same freezing point. Electrolytes, however, have higher osmotic pressures than Avogadro's law applied to solutions would give. This is explained by the dissociation or ionisation of salts in solution. Dissociation is a rather unfortunate term, as it is used for such splitting up as that of ammonium chloride into ammonia and hydrochloric acid when heated, in which cases both the bodies found are ordinary substances. In electrolytic dissociation, for instance, salt splits into sodium and chlorine. The chlorine and sodium atoms are not as in free chlorine and metallic sodium, but are electrically charged, and give up their charges to the anode and cathode. Only part of the salt is dissociated, the proportion not dissociated or ionised depending on the strength of the solution. Thus in a very strong solution very little of the salt is ionised. The term "ionised" is, perhaps, preferable to dissociated, as it suggests electrolytic dissociation as opposed to ordinary dissociation where the compound is not split into electro-negative and electro-positive radicles. As the solution is more and more diluted, the salt becomes more and more ionised. The electrical conductivity is due to the possibility of convection currents of the ions. The salt that is not ionised does not conduct. The current in the liquid consists of charged ions moving in different directions under the electric force. As the ions come against the electrodes they give up their charges, and are deposited as metals or given off as gas, as the case may be. The conductivity of a solution depends only on the number of free ions per cubic centimetre. A very strong solution has very few, so it conducts badly. As the solution is diluted, the ionisation goes on more quickly than the dilution, so that though there is less of the elements of the compound in a cubic centimetre, the proportion iodised is so much greater that the total number of free ions per cubic centimetre is increased, and with it the conductivity. As dilution proceeds, the ionisation no longer compensates for its effect, and we finally have a very dilute solution in which, though the ionisation is nearly complete, there are so few ions in a given volume that the liquid hardly conducts. Suppose, however, that we take a given quantity of the salt, and dissolve it in a right prism of water of a given length with electrodes at the ends, and measure, not the conductivity, but the conductance from plate to plate; as the liquid is diluted, the increase of cross-sectional area of the prism exactly counteracts the decrease of conductivity due to there being less of the elements per cubic centimetre, so that the increased ionisation tells independently. By this method, in fact, the combined charge carrying capacity of all the free ions in a given quantity of salt is measured, and it increases with dilution as the ionisation goes on, and tends towards a maximum at the point of complete ionisation, which exists at infinite dilution. By making a series of observations the molecular conductivity at infinite dilution, that is under the condition of complete ionisation, is found,

and the ionisation, or the proportion of the ionised part to the whole of the salt at any dilution can be found from the conductivity. The results so obtained account perfectly for the osmotic pressure of an electrolyte being greater than that of a colloid or non-electrolyte. After ionisation the separate ions act as molecules, so that a dissolved electrolyte behaves as if there were an extra number of molecules added, corresponding to the ionisation. Electrolytes also lower the freezing points of solutions, and raise their boiling points more than corresponding gramme equivalents of non-electrolytes; but the results are quantitatively right when ionisation is taken into account.

The current in an electrolyte consists of a convection transfer of charges due to the ions moving in different directions under the electric force. They move at different rates under a given electric force. This is a point of some importance in practical work, as it controls the concentration of the solution in the immediate neighbourhood of the cathode and anode. The movement or migration of the ions must not be confounded with electric osmosis, which is a different phenomenon. Suppose we electrolyse a solution of hydrochloric acid. This consists of water, which is very slightly dissociated, and may therefore be regarded as not conducting at all; molecules of hydrochloric acid which also do not conduct, for the hydrogen and chlorine have equal but opposite charges, and as they move together they cannot assist a convection current; and, finally, the solution consists of loose charged atoms of hydrogen and chlorine. They cannot be separated by diffusion, as in ordinary cases of dissociation, for as soon as the faster moving ions begin to diffuse into a new liquid their charges alter the potential of the liquids, and thus the electric force comes into play, keeping back the fast and helping the slow and oppositely charged ions. For every atomic equivalent of electricity that passes through the cell of dilute acid an atom of chlorine comes off at the anode and of hydrogen at the cathode. There are thus two atoms removed from the electrolyte by the passage of the electric charge of a single atom through the cell. If there were no movement of the ions there would then be a hydrogen atom close to the anode and one of chlorine at the cathode. As soon as there is an excess of atoms of this sort there is a difference of potential between the sides of the electrolyte, and this causes the ions to move across. If they moved equally, for every two atoms of chlorine and two of hydrogen deposited on the electrodes there would be a movement of one atom of chlorine and one of hydrogen in opposite directions across any surface separating the electrodes, and the liquid in the neighbourhood of the electrodes would be equally impoverished as to hydrochloric acid. But suppose the hydrogen atoms move five times as fast as the chlorine, for every six atoms of chlorine and six of hydrogen given off at the electrodes, five atoms of hydrogen and one atom of chlorine will pass an imaginary partition in opposite directions. The anode liquid will thus be impoverished by five molecules of hydrochloric acid, but the cathode solution will only lose one.

Space will not permit of a fuller account of electrolytic theory, and I must pass on to practical work, mentioning only a few processes.

The Ashcroft Process.

One of the most interesting of the more recent electrolytic processes is the Ashcroft method of treating the Broken Hill ores. As far as I know, this process has never been fully described in print, in fact, I do not know that it has been described at all. The directors have very kindly given me permission to explain it as fully as I can, so I take the opportunity of doing so.

As is generally known, the Broken Hill mines contain enormous quantities; in fact, millions of tons of argentiferous sulphide of lead and zinc. Where this has been exposed to the weather for many thousands of years, the zinc and lead sulphides have been oxidised, and the zinc salts have been washed away. The lead and silver are then very easily dealt with metallurgically. The exposed and oxidised ore is nearly done now. Although enormous quantities of lead and silver have been taken from the Broken Hill mines, all that has been done, so far, is but a mere scratching of the surface compared with what there is still to do. The sulphide of lead and zinc is, however, a very troublesome ore to deal with. The zinc prevents it being treated as a lead ore, and the enormous mass has been regarded as valueless until some process for treating could be discovered. The lead and zinc sulphides are very intimately mixed, so that concentration is exceedingly difficult. Of course there have been endless schemes for the treatment of this ore, and probably every inventor in Australia has devoted some attention to the matter; but until the Ashcroft process was invented, nothing very promising had been brought forward.

The Broken Hill ore may be taken to consist, roughly, of 30 per cent of lead as sulphide, 30 per cent. of zinc as sulphide, and 25 to 30 ounces of silver to the ton. There is not much gangue.

In the Ashcroft process the ore is first ground—not too fine—and then roasted. This converts the zinc sulphide mainly into oxide. Of course the sulphide can be roasted till practically all the zinc is in the form of oxide, but it is most economical in this case not to roast so far. It will be said that this involves waste of zinc in the form of solution of sulphate, but the zinc at this stage is practically of no value. It pays better to allow a certain amount of zinc to be wasted, rather than to go to the expense of roasting into oxide.

The roasted ore is then leached with a solution containing persalts of iron, and salts of zinc, sulphates, and chlorides. The oxide of zinc in the roasted ore is dissolved as sulphate or chloride, while the iron is precipitated as ferric hydrate. The ferric hydrate is apt to remain in its colloidal form, but the solution is heated and the iron thrown down. The solid matter is allowed to settle, and the solution is run off. The solid matter contains all the lead, and some of the silver, and some zinc. There is so little zinc, however, that it gives no trouble in smelting. The iron oxide is also required for smelting, and would have to have been added in any case.

The solution is led through tanks containing zinc plates or shavings to catch any silver. It then goes to electrolytic vats, and some of the zinc is taken out. The anodes in these vats are iron, so that iron goes into solution as ferrous chloride or sulphate. A diaphragm is used, to prevent the solution mixing. The mixing of the solutions would be fatal to the process, because iron would be deposited on the zinc. This would not only give zinc containing iron, but it would prevent the zinc coming down properly. It is by no means easy to produce a smooth, even deposit of zinc of any thickness; and as soon as a deposit begins to come down badly, it is very troublesome to get it right again. In order to prevent any chance of iron getting into the cathode chamber, the liquid on this side is kept at a slightly higher level, so that there is always a current through the diaphragm which prevents any trace of iron getting in. The liquid from the cathode chamber which has been deprived of some of its zinc, is led to a second set of vats in which more of the zinc is taken out. The solution is then led to the anode chamber first described, so as to take up iron in the ferrous state. The ferrous solution is then led to the last vat, which has carbon anodes instead of iron. This converts the iron into ferric salts, and this solution, which contains ferric and zinc salts, is used for leaching the roasted ore. The process is thus cyclic.

Most people who have had experiences of leaching processes may be inclined to think that there must be difficulty in getting the iron completely thrown down by the roasted ore. The leaching, however, goes beautifully at once, and, after heating to deposit ferric oxide, there is no trace of iron to be found in the solution. It is necessary, of course, to have excess of zinc oxide, to make sure that all the iron is thrown down. Traces of aluminium and manganese salts may find their way into the solution, but that does not matter, as they cannot accumulate beyond a certain amount, as will be explained immediately.

The leached ore and oxide of iron contains a good deal of solution, so that a certain amount of zinc salts is taken with it. As the clear solution is separated from the sludge by decantation, and the sludge is still liquid enough to be run off into settling tanks, it might be that it would pay to save the solution of zinc, but this is not the case. If the solution could be perfectly separated so that none was thrown away, and no new solution was added, the impurities would accumulate until they gave trouble in the depositing vats. A certain proportion of the solution is, therefore, allowed to go off with the slimes, and the solution is made up with sea water.

As explained already, the roasted ore contains zinc in the form of sulphates, and of oxide. A basic sulphate may for the moment be regarded as a mixture of oxide and sulphate. The circulating system thus consists of a stream of solution which, after leaving the leaching vats, has its silver removed, and then goes through cathode chambers, where about one-third of its zinc is taken. It then goes through anode chambers while it takes up the iron, which in the second set of anode chambers is converted into the ferric state, and the ferric salt is changed for zinc salt in the leaching.

It is only zinc in the form of oxide that is taken up in the ferric solution; that in the form of sulphate goes into the solution without any corresponding precipitation of iron. This zinc is useless, as it cannot be deposited in the tanks. All the zinc taken up as sulphate by simple solution is thus wasted. This is a very curious result, but a little consideration will show that it must be so. The zinc deposited in the vats is, of course, accurately in proportion to the iron dissolved. The vats must be arranged so that the iron anodes have twice the current of the carbon vats, otherwise there would be chlorine liberated, or ferrous salts in the leaching solution, as the case might be. This result is easily secured by having two iron vats in series with one carbon cell. Suppose two gramme equivalents of zinc—that is to say, 130 grammes of zinc—are deposited in the cells with iron anodes, two gramme equivalents of iron—that is to say, 112 grammes—are dissolved as ferrous salt; in the next cell, with carbon anodes, the ferrous salt is raised to the ferric state, and another gramme equivalent of zinc is thrown down. For every three gramme equivalents of zinc we thus have two gramme equivalents of iron, and two gramme equivalents of ferric salt act on three gramme equivalents of zinc oxide in the leaching vats. The zinc deposited is, therefore, equivalent to the iron, and is thus the zinc that is taken up by action of the ferric salt on the oxide. If the same liquid always circulated without any being drawn off, the zinc would increase till the solution was saturated as regards zinc sulphate. The zinc sulphate is therefore drawn off, to some extent, with the slime after leaching. It may be utilised by other processes, but as far as this process goes, it is a waste product. It still pays, however, not to trouble to roast the zinc sulphide completely into oxide.

Only about a third of the zinc is removed from the solution during one tour through the electrolysis house. There has always been some difficulty in getting a good, smooth, dense deposit of zinc. It is very apt to come down in a spongy form, and in this case it is practically impossible to deposit it commercially. For that reason, many people have advocated the use of alkaline solutions of zincates, such as the solution of zinc oxide in caustic soda. On the other hand, zinc sulphate will sometimes give very perfect deposits; and zinc sulphate was the electrolyte employed in the Edison electrolytic meter, where it seemed to work with almost perfect success. The deposition of zinc on a large scale from the sulphate has, however, generally given great trouble. In the Ashcroft process this trouble is overcome by the use of a solution containing basic sulphate and chloride of zinc. There is always excess of zinc oxide in the ore, that is to say in leaching, the roasted ore and iron solution are so proportioned that there is more oxide than the iron can deal with. Though the basic salts of zinc are insoluble in water, they are fairly soluble in solutions of the corresponding neutral salts, so that the electrolyte really contains basic salts. This seems to make all the difference in the nature of the deposit. Even then the deposit is somewhat brittle. New wooden vats will sometimes add something to the solution, which makes the deposit come down badly.

The vats are wooden tanks and the cathodes are sheets of zinc suspended in cells which are dropped into the larger cells. The

diaphragms are made of close texture canvas. The anodes are crude wrought-iron. It is probable that crude pig iron will do, but cheap wrought-iron is at present used. The circulation is arranged so that the current of liquid through the cathode chambers is quite distinct from the anode circulation; the liquid in the cathode chambers being kept at a little higher level as already explained, so as to make sure that no iron gets into the cathode cells. For the carbon electrodes either plates or rods of the same material as electric light carbons are used. This material is, of course, expensive, but it is not practicable to arrange for retort carbon, or any other cheap substitute, as to get a reasonable output from a given area of a vat house, the vats have to be deep. The circulation systems make it difficult to have sets of shallow vats one above the other. The carbon is attacked to some extent, but the corrosion is small, as there is plenty of chloride available. The oxidation has to be carried a trifle further than would suffice for the complete conversion of the ferrous into a ferric salt, so that a trace of chlorine or hypochlorite is formed. This oxidises any traces of ferrous salt that may not have come into contact with the anodes. It is most important to have no ferrous salt in the leaching vats, as they are not precipitated by zinc oxide, and would find their way into cathode vats, and spoil the deposit.

This process is the invention of Mr. Edgar A. Ashcroft, and is now owned by the Sulphide Corporation (Ashcroft's process), Limited, who are commencing to work it in Australia. This company also owns a block of the Broken Hill mines, so that they have an almost unlimited supply of raw material to work upon. The process has already been worked on a manufacturing scale, and works are now being started in Australia and the United States.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

21,449. "Improvements in apparatus for measuring and recording electric currents." H. Aron. Dated September 28th.

21,487. "Improvements in or connected with coin-freed or actuated electricity meters. G. Ellis and G. H. Nisbett. Dated September 29th.

21,488. "Improvements in or connected with coin-freed or actuated electricity meters." G. H. Nisbett. Dated September 29th.

21,509. "An improved electrolyser or electrolytic apparatus." J. G. A. Rhodin. Dated September 29th.

21,527. "Improved door or sash bolt for use in connection with electric circuits." J. J. Wilson. Dated September 29th.

21,539. "Improvements in or relating to telephones." A. J. Boult. (G. M. Blair and C. W. Ream, United States.) Dated September 29th.

21,559. "Improvements in dynamo-electric machines." The British Thomson-Houston Company, Ltd. (C. P. Steinmetz, United States.) Dated September 29th. (*Complete.*)

21,560. "Improvements in tandem-parallel controllers for induction motors." The British Thomson-Houston Company, Ltd. (W. B. Potter and F. E. Case, United States.) Dated September 29th. (*Complete.*)

21,561. "Improvements in the means of supplying current to electrically propelled railroad vehicles." F. J. Warden-Stevens. Dated September 29th.

21,591. "Improvements in or connected with electric circuits for telephonic communication." F. Rumbicke, J. Juraske and H. Brockett. Dated September 29th. (*Complete.*)

21,614. "Improvements in and relating to cut-outs and similar devices for electric circuits." A. Von Wurstemberger. Dated September 30th. (*Complete.*)

21,617. "Improvements in electric heating devices." W. E. Heys. (D. Chedville, France). Dated September 30th.

21,668. "Centrifugal contact apparatus for effecting the connection of the armature windings of rotary phase electromotors on the attainment of a certain speed." Siemens Bros. & Co., Ltd. (Siemens and Halske, Germany). Dated September 30th.

21,684. "Improvements in joints for electric light fittings." J. W. Singer, W. H. Singer, and E. R. Singer. Dated September 30th.

21,688. "Improved means of applying electricity to the human body." W. P. Thompson. (Karl Zirahal and J. Minarik, Austria). Dated September 30th.

21,749. "Improvements in active material for secondary battery plates." The Sussman Electric Miners' Lamp Company, Ltd., and S. A. Rosenthal. Dated October 1st.

21,809. "Improvements in electrical burglar alarms." J. H. Bower. Dated October 2nd.

21,822. "Improvements in leading-in wires of electric glow lamps." G. Davis. Dated October 2nd.

21,826. "Improved grids for plates in secondary electrical batteries." T. Froggatt. Dated October 2nd.

21,879. "An electric furnace or] oven." C. A. Timme. Dated October 2nd.

21,930. "An improvement, or improvements, in the method of ensuring a quick break in electrical switches, known as the 'knife' switch 'chopper' or 'hatchet' switch.' G. H. Verity. Dated October 3rd. (*Complete.*)

21,956. "Improvements in, or connected with, electric accumulators." J. Julien. Dated October 3rd.

21,960. "Improvements in electric bells." J. Mohr. Dated October 3rd. (*Complete.*)

21,966. "Improvements in indicators for conduits." G. C. Marks. (G. Christie, France.) Dated October 3.

21,972. "Improvements in dynamo-electric generators and motors." S. G. Brown. Dated October 3rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps*).]

1896.

5,951. "Improvements in the suspension of motors for electric cars." J. Devonshire. (N. C. Bassett, United States.) Dated March 17th, 1896. Relates to a suspension for electric car motors, comprising a flexibly supported truck frame, a wheeled axle mounted in the frame, a motor sleeved upon and geared to the axle, and a spring support for the other end of the motor, consisting of a bar or yoke bent so as to be supported by springs upon the truck frame at substantially the plane of the centre of gravity of the motor. 3 claims.

6,925. "Improvements in and connected with electrical water level indicators for steam boilers." H. Biermann. Dated March 30th, 1896. Relates to an electric water level indicator for steam boilers of all kinds, which consist of a float and an electric contact making device in combination with the water gauge glass. These are so arranged and constructed that an electric circuit is closed through a spring armature and a spring latch, whereby an electric motor feed water supply alarm and brake safety, or other apparatus connected with such motor, is brought into action whenever the level of the water reaches its lowest permissible limit. 2 claims.

10,817. "Improvements in and connected with electric brakes for electrically propelled vehicles." J. Devonshire. (W. B. Potter, United States.) Dated May 19th, 1896. Relates to electric brakes and the combination of a controlling switch arranged to connect a plurality of motors in series or in parallel with or without resistance, and an emergency switch in the controller provided with contacts and connectors arranged to open the trolley circuit, and to close a local circuit through the motors, the local circuit being left open at the controller. By this arrangement the controller may be used as power apparatus in one position of the auxiliary switch, but in other positions will combine the motors as generators in steps and series and parallel, with and without resistance. Refers to Specification No. 14,639 of 1895. 1 claim.

11,417. "Improved means for electrically connecting the rails or sections of electric railways." R. C. Brown and F. E. Huntress. Dated May 26th, 1896. Relates to an improvement in electric railway construction, in which the rails of the track form part of the circuit, consists in the combination with the rails of a railbond, comprising hollow plugs inserted through the rails to be connected, a tie wire extended into the hollow plugs and soldered thereto, and a sleeve or tube into which the ends of the tie wire are inserted and soldered. 3 claims.

12,344. "Method of indicating at a telephone station whether the telephone lines are engaged or not." E. Naglo. Dated June 5th, 1896. Relates to a method for indicating whether the subscriber's lines led into a telephone station are engaged or not, wherein on calling, or the falling of the call relay or indicator shutter, and also on plugging a jack, the circuit of a glow lamp carrying the number of the circuit is closed or opened, either directly or through the medium of a relay, so that the appearance of the number of the circuit will indicate in the one case that the line is engaged, or in the other case that the line is free. 2 claims.

13,723. "Improvements in and in connection with incandescence electric lamps." G. Germer and F. A. Huller. Dated June 22nd, 1896. Consists of a porcelain ring on the lower part of the lamp neck, so fixed, that the upper part, with the conducting wires embedded, remains free. The ring is provided with a guard of non-conducting material, which bridges over the place of connection, and protects connections of the platinum wires and the conducting wires, and serves to prevent rupture between these wires. The ring is also provided with nipples for the attachment of the socket, which has grooves for taking the nipples of the ring. 1 claim.

13,889. "Improvements in and relating to electrical distribution." L. K. Oppenheimer. Dated June 23rd, 1896. Relates to a method of distributing electrical energy to a plurality of translating device circuits. This method consists in supplying successive electrical impulses to said circuits, the rates of the duration of said impulses to the duration of the intervening periods of cessation being approximately as the ratio of one-half of the electromotive force required by the translating devices, when constantly supplied with current, is to the electromotive force employed in excess of that required by said translating devices when constantly supplied with current. 2 claims.